

6656

# The Mining Journal

PR

UNIVERSITY OF MICHIGAN

APR 10 1959

SCIENCE LIBRARY

LONDON, APRIL 10, 1959

Vol. 252. No. 6451.

Price Ninepence



U.S. Granite  
Air Hose  
in a mine  
in  
North  
Portugal

**US** RUBBER **GRANITE**

## AIR HOSE *in world-wide use*

A thick cover of high-quality natural rubber and a neoprene lining to resist the corrosion of hot oil have made U.S. Granite air hose first favourite in mines and quarries throughout the world. Widely known as hardwearing and super-resistant to severe service conditions, U.S. Granite is to be found operating in all five continents.



### U. S. Rubber

Home: The North British Rubber Company Limited, ABBey 7135  
Export: U.S. Rubber International (Great Britain) Ltd. ABBey 2053

62/64 HORSEFERRY ROAD, LONDON, S.W.1



# MINING MACHINERY EXHIBITION

GRAND HALL  
OLYMPIA • LONDON  
9th-18th JULY 1959

*Please write for further information to :-*

The Secretaries,

THE COUNCIL OF UNDERGROUND MACHINERY MANUFACTURERS  
301 • GLOSSOP ROAD • SHEFFIELD • 10

# The Mining Journal

London, April 10, 1959

## In this issue . . .

The Leggett Touch . . . . .	387
Artificial Consolidation of Strata . . . . .	388
The Ironsands of North Island, New Zealand . . . . .	388
Heavy Weather for Ceylon's Graphite Industry . . . . .	389
Poland's Copper Potential . . . . .	389
The European Coal Situation . . . . .	389
Chemical Solidification of Soil in Tunneling . . . . .	390
Asbestos in Southern Rhodesia . . . . .	392
Microbiological Processes in Mining . . . . .	393
Machinery and Equipment . . . . .	395
Mining Miscellany . . . . .	396
Metals and Minerals . . . . .	397
London Metal and Ore Prices . . . . .	398
Mining Finance . . . . .	399
Obituary: Joseph Rousseaux . . . . .	400
Coming Events . . . . .	400
Company Meetings . . . . .	401
Rand and Orange Free State Returns for March . . . . .	401
The Engineering, Marine, Welding and Nuclear Energy Exhibition, 1959 . . . . .	402
Book Reviews . . . . .	402

Vol. 252

No. 6451

Established 1835

### Editor

U. Baliol Scott

### Deputy Editor

A. Graham Thomson

### Assistant Editor

R. Bowran

### Assistant Financial Editor

R. A. Nuttall

### Display Advertisement Manager

E. S. Hooper

### Circulation

Robert Budd

Published each Friday by

**THE MINING JOURNAL LTD.**

### Directors

E. Baliol Scott  
(Chairman)

U. Baliol Scott  
(Managing)

G. A. Baliol Scott

R. A. Ellefsen

**15 WILSON STREET,  
LONDON, E.C.2**

Telegraphic  
Tutwork London

Telephone  
MONarch 2567 (3 lines)

Annual Subscription £3 5s. Single copy ninepence

## The Leggett Touch

SO far as can be judged from the meagre information reaching London, Sir Frederick Leggett has done a good job for the Copperbelt in producing his recommendations for helping to keep the copper mining industry free from strikes. His suggestions are not only patently sound, they are already known to be acceptable to the Northern Rhodesian Government (which had invited him to undertake the job) and to the European Mine-workers' Union and the companies.

His suggestions have not only won the approval of union and companies, they are also framed to meet both their objections. The union had felt that there was something wrong with the machinery of negotiation; the companies had taken the view that the machinery was adequate if only the will were present on both sides to see it used. What Sir Frederick has done is to accept the companies' view to the extent of leaving the existing legislation alone, and to accept the union's view to the extent of giving the existing machinery a fresh emphasis.

In brief, his recommendations are believed to be threefold: first, that the lower levels of management — the foremen, shift bosses, supervisors and other officials — should have greater status and authority for settling disputes directly they arise; secondly, that three-day cooling-off periods should be woven into the negotiating machinery in order to prevent minor disputes passing rapidly into major ones without the time to give them much thought; and thirdly, that there should be what in England would be called a joint industrial council that would meet regularly — perhaps once a month — to discuss common problems including such matters of dispute that happened to be before the industry.

The second suggestion, while being in some ways the most novel, is yet the simplest of the three. The best known example of the cooling-off technique is the clause in the American Taft-Hartley Act which requires a gap of several weeks between a decision to take strike action and the starting of the actual strike. This is not intended to slow down the pace of negotiation but to allow the union to reflect on the gravity of their step and to allow the government to intervene if they want to.

Cooling-off is not a technique that is required in Britain. But on the Copperbelt the facts that the industry is so compact, the negotiating machinery so straightforward, and the officials on both sides not distracted by the multifarious duties that weigh on British or American labour negotiators, mean that a problem can be very quickly dealt with up to the stage that it arrives on the table at the Chamber of Mines as a full-blown dispute. Whereas in Britain the usual complaint is that negotiating machinery is too slow, on the Copperbelt it is obvious that in many instances it has proved too rapid.

The suggestion that more power should be given to the lower levels of management so that they can settle disputes, so far as they are able, is obviously sound. But it will mean that the copper companies will need to strengthen the training of their foremen and shift bosses in this sort of work. They will need the know-how of settling disputes as well as the authority to do so. In the same way the union will have to consider whether their own shop



stewards in the actual mines are equipped to do this sort of work. When it works well the shop steward system is a tremendous help; when it works badly it is a menace. The system may even come to rival the authority of the union officials, and when that happens there is endless opportunity for trouble.

It is the third suggestion—that there should be some sort of industrial council—that is the most interesting and perhaps the most fruitful. It is proposed that there should be a council of six members from each side, each side having a secretary and each in turn providing the chairman. The council would meet regularly—once a month perhaps—and would try to settle such disputes as had not been settled by earlier attempts. If the council failed, then the matter would go on in the ordinary way to the conciliation and voluntary arbitration procedures that already exist.

What is important is that the meetings would be regular, whether or not there were disputes to hear. This would mean that the members would get to know each other in a reasonable atmosphere and their meetings would not be restricted as they now often are to the times when there is a strong difference of opinion between them. Furthermore, in the months when there are no disputes to discuss, they will want to talk over matters of common interest (if only in the first instance to pass the time) and this will lead naturally to co-operation in various fields as well as to a more tolerant approach to the disputes when they actually do arise.

Having said this, it must be admitted that there are some ragged edges. This will presumably be a council of the European Mineworkers' Union and the companies. But there will be occasions when matters crop up that have a bearing on other unions. It would be negotiation run mad to have four joint councils; it would be politically impossible to have two separated by colour; it would equally be impossible at present to have a single council that would take in all four unions. Yet partly because of the problem of possible overlapping and partly because a joint council is not a privilege to be conferred but a practical device for avoiding trouble, it is difficult to see Sir Frederick's present recommendation as more than a starting point. It will have to develop. But it is by no means clear in what way it will develop.

This perhaps may explain what seems a curious reluctance to publish a detailed summary of the Leggett proposals. This was perhaps a defensible attitude until a fairly massive leakage developed; thereafter it was hard to see what was to be gained by not putting the cards fully on the table. There is bound to be comment on such matters; it is always as well to see that it is informed comment.

After all, the general trend of the Leggett proposals is to make the negotiating machinery a little less rigid, a little less legalistic, and on the other hand to make it more human and tolerant. Much the same people will be meeting in a rather different way that will, it is hoped, make them have more confidence in each other. This is not a hand that calls for playing close to the chest.

## ARTIFICIAL CONSOLIDATION OF STRATA

During 1958 the conception of supporting mine walls by some form of artificial consolidation gained further ground in wake of the impressive results previously achieved by the use of rock bolting. In its essentials, artificial consolidation involves the injection of high-strength adhesive materials into the bedding planes of stratified rock layers. Individually weak layers are thus bonded into a competent bed.

Preliminary work accomplished in the United States has given rise to some optimism for the future of the artificial consolidation method. These preliminaries have indicated that coal measure strata can be successfully injected and the planes penetrated by high-pressure oil. Indeed, work was carried out during the last year to establish a suitable bonding medium that would give the effect of a compound beam. The properties of epoxy resins have caused these materials to be the subject of wide research as a bonding medium, and although results have by no means been conclusive, the work carried out so far indicates that the idea has definite possibilities. So that if the artificial consolidation of strata could be made a practical proposition, the system would have decided application in the pre-bonding of hanging walls ahead of the working face, with the obvious beneficial results.

A further interesting example of artificial consolidation of strata in mining operations has been reported by the U.S. Bureau of Mines, in describing how an incline being driven to accommodate an ore conveyor encountered a thick, horizontal bed of water-bearing sand. Eventually, chemical soil solidification was utilized to stabilize the sand in the path of operations. The process employed was that originated by H. G. Joosten, in which consecutive injections of a sodium silicate solution and a strong saline solution brings about a very rapid precipitation of silicic gel. This gel coats the individual sand particles with a thin film having a high-surface tension. Thus the separate particles of the treated mass are cemented and, as the gel fills the spaces between the particles, water is forced out and sealing is effected.

This particular application is of interest, as the method was used over a total tunnel length of 178 ft., and, therefore, it cannot be said that in this instance artificial consolidation was employed experimentally only. The operations at Tioga No. 2 Pit, of Picklands Mather, are more fully described on page 390 of this issue.

## THE IRONSANDS OF NORTH ISLAND, NEW ZEALAND

For the purpose chiefly of assessing the ironsand deposits in New Zealand's North Island as a source of iron and steel, bearing also in mind the possibility of obtaining by-product titanium and vanadium, a borehole survey has recently been made of the coastal area north of New Plymouth on the west coast of North Island. A paper on the survey, prepared by Mr. D. S. Nicholson and Mr. H. E. Fyfe, of the New Zealand Department of Scientific and Industrial Research, has recently been published in *The New Zealand Journal of Geology and Geophysics*.

According to the report, the Lake Taharoa area south of Kawhia Harbour is potentially the most important deposit of ironsand on the whole coastline. Although deep drilling will be necessary to confirm the extent of this deposit, it has been estimated that the field may contain as much as 173,000,000 tons. This compares with a content of about 14,000,000 tons of potential concentrate in the Patea area further south, as recorded by the Department of Mines.

In order of importance, the next deposit is that at Muriwai, 30 miles north-west of Auckland, where it is estimated that the two southernmost miles of beach and dune above sea level contain about 17,600,000 tons of recoverable ironsand. Evidence indicates that the deposit probably extends below sea level, an important factor, since other conditions also make the deposit suitable for mining by bucket or suction dredge.



Indicated as next in importance is a deposit at the mouth of the Marokopa River, where there are about 29,000,000 tons of recoverable ironsand. Though this deposit is larger and of a higher grade than that at Muriwai, it is not considered so important economically because of the greater difficulty of access and the fact that it is not suitable for mining by dredging. Also of high grade are the small deposits at the mouth of the Mokau and Awakino rivers, which empty into the Taranaki Bight, but here again inaccessibility and the smallness of the deposits may prevent development.

There are also considerable deposits in the Kawhia, Aotea, and Raglan Harbour areas, and at Waikato Heads, all of which are in the same general region, but they are low in ironsand content, and it is considered doubtful if they will ever warrant development. A deposit at Piha is also too small to warrant development. Generally, the deposits north of New Plymouth contain a better grade of ironsand than do those to the south.

Plans have been under consideration for some time for a major iron and steel industry based on the ironsand deposits, but such a scheme may take some time to develop and one estimate is that about ten years must elapse before fruition, with a cost approximating £25,000,000.

At present, New Zealand imports about 350,000 tons of steel and 7,500 tons of pig-iron a year. The United Kingdom firms of Colvilles and Stewarts and Lloyds are planning, together with the New Zealand companies of Fletcher Holdings and Industrial Metals and others, to establish in New Zealand a steelworks based on scrap. This is not, however, intended to affect the long-term plans for an industry based on the ironsand deposits.

## HEAVY WEATHER FOR CEYLON'S GRAPHITE INDUSTRY

The Ceylon Merchants' Chamber has urged the government to waive the export duty on graphite as an immediate measure of relief to the industry, which is now passing through a critical period. In a memorandum to the Minister for Finance, Mr. Stanley de Zoysa, the Chamber states that graphite exports have been declining over the years and have fallen by nearly 30 per cent since 1957.

Ceylon's graphite exports to the United States—one of the principal markets—have been steadily declining as a result of very strong competition from Madagascar, West Germany, British East Africa, Mexico, Norway, and Hong Kong. If Ceylon is not in a position to compete with these sources, the United States market for Ceylon graphite is expected to be affected still further, and it will probably be too late then to recapture this valuable market.

The Chamber states that mineowners and exporters should be placed in a position to meet foreign competition, but this could not be achieved with an export duty as high as Rs.50 a ton on graphite. At the same time, shipping freight rates have increased, while delays in the Colombo port have aggravated the position still further.

Ceylon is also losing the United Kingdom market for graphite. The Chamber has been informed by one of the largest graphite importers in the United Kingdom that the "future market conditions for Ceylon graphite are not as good, since a number of users of graphite in the United Kingdom have definitely gone over to using graphite of other origins that are suitable for their purpose and much cheaper than the Ceylon product".

Meanwhile, hundreds of workers are threatened with the prospect of unemployment as a result of the slump in the graphite industry.

## POLAND'S COPPER POTENTIAL

Rapid progress is being made in the development of Poland's Lower Silesian copper basin. Within the next five-year period the first copper mines of that area will commence the exploitation of the rich deposits near Lubin. At the moment, operations are confined to increasing the output of the existing mines in the Boleslawiec-Zlotoryja zone. It is claimed that total output in this latter district will reach a total of over 2,000,000 tons of copper ore annually by 1965.

A survey of some of the copper properties of Lower Silesia shows that the Konrad mine is reported as regularly exceeding its output quota, while in addition employment of a new flotation technique ensures a higher grade of copper recovery. The Konrad's output for 1959 is expected to exceed 500,000 tons of ore, rising to 1,200,000 tons in 1965. Towards the end of this year the main pit at the Konrad will be ready for exploitation. Two new flotation plants are being built on site.

A second new copper property, the Lubichow mine, is now being opened up and the first surface installations are being built. The new mine is likely to commence operations in 1960, while Poland's overall copper production capacity is likely also to be expanded by the output of the Nowy Kosciol property, now being "considerably developed".

## THE EUROPEAN COAL SITUATION

Despite efforts to curb coal output, stocks are continuing to mount in Western Europe. In Britain, stocks of unsold coal now stand at 21,000,000 tons and in the Pool countries almost 26,000,000 tons are reported to be standing at the pitheads.

The British National Union of Mineworkers have certainly picked an unpropitious moment to present their latest series of claims and not unexpectedly these were recently rejected by the Coal Board. The N.U.M. asked for a shorter working week of 35 hours and a third week's holiday with pay. The Board replied that to concede these claims would cost some £75,000,000 per year. At a time when the industry was already striving to preserve markets for coal against price competition, this cost would be an intolerable financial burden and would lead to the danger of more collieries having to close.

On the Continent centralized control of the European Coal and Steel Community's coal industry has been suggested by the High Authority as a means of alleviating the position caused by the current coal glut. The scheme proposes the reduction of imports by a co-ordinated commercial policy for the six member nations and the freezing of stocks at their present level by flexible regulation of production.

Such flexibility as this would not be achieved by an adherence to hard-and-fast national quotas but apparently by adjustment at colliery level. The proposed scheme has been rejected by the West German Government, conditionally approved by Italy and approved by Belgium, Holland and Luxembourg. The remaining member state, France, is withholding judgement until more details are available.

Unemployment in the E.C.S.C. coal industry is currently some 7 per cent. Attempts to put the present unsold stocks of coal on to the market would result in more than one in four of the miners in the Community being put out of work.

## Chemical Solidification of Soil in Tunnelling

THE Tioga No. 2 open-pit in Minnesota was mined for iron ore by Pickands Mather and Co. Production from the mine was begun in 1955; 564,517 tons of ore were shipped in 1956. The ore is low grade and is concentrated either by washing or by heavy-medium methods.

Ore was loaded into trucks by electric shovels, hauled to a pocket at the bottom of the pit, and passed over a screen; the oversize ore was crushed and carried with the undersize ore to the mill by a single flight belt conveyor. During development of the mine, the best method of bringing the belt out of the pit was given considerable thought, resulting in installation of the belt in a tunnel driven into the pit bank.

The decision to drive a tunnel through the pit bank was made with the realization that a fine grey-sand horizon could present a problem if water was found. Overburden consisted of 22 ft. of clay and gravel, 15 ft. of grey marl, 35 ft. of yellow sand, 25 ft. of marl, 22 ft. of fine grey sand, and 81 ft. of marl. The fine grey-sand horizon had presented difficulties during stripping, which had drained the immediate area; but before the final decision, two test holes were drilled along the line of the proposed tunnel. Little evidence of water was found in the test holes. Final plans included a 2,265-ft. conveyor flight with a total lift of 254 ft. The 9-ft. dia. circular tunnel section was 972 ft. long and inclined about 12 deg. Steel liner plates, 16 in. wide, 9 plates to a ring, were used for support.

### Early Operations

Excavation of the tunnel was begun at both the upper and lower ends, and three-man crews were employed at both faces. Holes were drilled in the marl formation with percussion machines and auger bits. Just enough explosives were loaded in the 4-ft. holes to shake up the ground. The cut was completed with pneumatic clay spades, and the dirt was removed from the tunnel with scrapers pulled by electrically-powered tuggers.

Difficulties were not experienced in the marl formation, but progress was soon halted when the fine grey sands were encountered. Conventional methods of advance failed, and the tunnel section near the face in the upper heading began to take weight, resulting in deformation of the steel rings. In an attempt to stabilize the ground, grouting was begun

*The following article is condensed from "Chemical Solidification of Soil in Tunnelling at a Minnesota iron ore mine", published by the U.S. Bureau of Mines as Information Circular 7846.*

out by the damaged section of the tunnel. The grout was pumped through holes cut in the steel liner plates to form a complete seal around the tunnel. This procedure was followed until the seal was completed to the tunnel face.

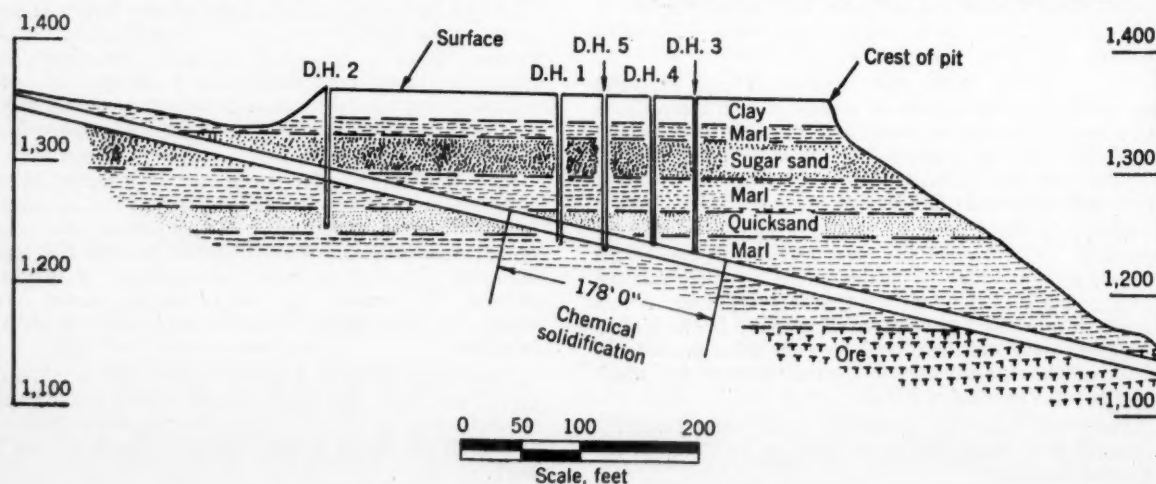
Attempts to grout the strata in advance of the tunnel through pipes in the face and from surface failed. Little or no grout could be forced through the face pipes, and the grout injected through the surface pipes disappeared to some unknown area. After a run of wet mud and sand occurred at the face of the lower heading, the grouting was discontinued, and a chemical soil-solidification company was engaged to stabilize the sand in the path of the tunnel excavation.

### The Joosten Process

The Joosten process is a method of chemically solidifying loose sands and soils that are permeable to water. The purpose of the process is to solidify and seal strata of loose sand permeable to water and such other structures as are porous and subject to decomposition. The process consists of consecutive injection of two solutions, which will instantly bring about precipitation of silicic gel. Essentially, the first solution is an almost saturated solution of sodium silicate (waterglass) and the second a strong saline solution, such as calcium chloride. The chemical reaction of the solutions within the treated mass results in the precipitation of a silicic gel, which coats the individual sand particles with a thin film having high surface tension. Thus the separate particles of the treated mass are cemented, and as the gel fills the spaces between particles, sealing is effected. Excess water is pushed beyond the solidifying range owing to additional pressure as cementation continues.

Some of the advantages claimed for the Joosten process are: There is immediate solidification with no setting time required; there is no dilution of the chemical solutions by

Section of tunnel showing area chemically solidified



## Schematic hookup of injection equipment

ground waters; solidification is independent of the nature of the soil and little affected by the chemical properties; few items of equipment are needed; and the method can be used for underground work. The process uses true solutions which penetrate small-pored and fine-fissured material that would filter out cement in suspension.

The amount of equipment needed is not excessive, and a typical installation generally is listed as:

- (a) Injection pipes similar to well points. Special driving heads and pipe connections designed to stand punishment are needed when driving through highly packed soil or withdrawing from the solidified area at great depths;
- (b) Compressed air hammer and drop hammer or pipe-pusher for driving the injection pipes;
- (c) Double-acting chemical pumps to provide pressures up to 400 p.s.i.;
- (d) Pressure hose with attachments of a type that will permit quick disconnection;
- (e) Suction tanks;
- (f) Paddle-type mixing equipment for mixing chemical No. 2 (usually calcium chloride) at the site;
- (g) Heavy twin hydraulic jacks for withdrawing pipes from injection area;
- (h) Miscellaneous pipefitters' tools.

A supply of water for mixing the chemicals and flushing pipes and a source of compressed air at 100 p.s.i. are required.

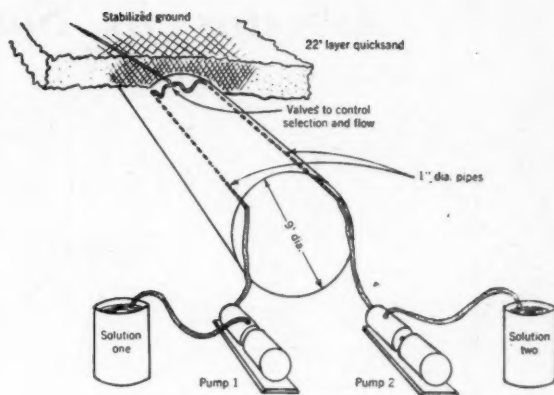
A crew of one experienced foreman, one pump operator, one pipe keyman, and two labourers is usually enough to handle the actual injection work at one tunnel face. The foreman and pump operator should be thoroughly familiar with the chemical-injection equipment, but labour can be hired locally. On larger jobs three injection crews or more can handle one compressor and mixing plant.

## Application at Tioga No. 2 Mine

Chemical solidification of the sands was begun at the upper heading. The solutions of sodium silicate and calcium chloride were prepared at the tunnel entrance. Compressed-air pumps, attached to the solution tanks, forced the solutions to the tunnel heading through 1-in. dia. lines. The injection pipes were made from A-section diamond-drill rods. A special spear-shaped driving head was used with the rods. Driving was accomplished with pneumatic hammers, and the pipes were withdrawn from the holes with hydraulic jacks. A communication system was set up to permit conversation between the face and the pump station.

Three series of pipes were driven at the face for introducing the chemicals. One series was driven around the circumference of the tunnel just back of the existing face to a depth of 3 ft. A second series was driven ahead of the face and flared to the sides to solidify a section in the form of a truncated cone. A third series of pipes was driven ahead of the tunnel and in the line of advance to a distance of 8 ft. This pattern gave a solidified area large enough to permit a safe tunnel advance of 6 to 10 ft. with a 2-ft. thickness of firm ground left in the face.

After the pipes were driven to the desired depth, a specified quantity of sodium silicate solution was injected under pressure. This forced out and replaced the water in the immediate area. The pipes were then flushed sparingly with water, and the calcium chloride solution was injected. Pipes were then withdrawn 1 ft., and the cycle of injections



of sodium silicate and calcium chloride solutions was repeated. This process was repeated until the pipes were withdrawn from the holes.

In any particular job of chemical soil solidification the pattern and spacing of pipes, injection pressures, and viscosity of solutions will be varied by an experienced engineer to fit the conditions. Determination of grain size, permeability of the mass to be treated, and laboratory solidification tests of representative soil samples to determine proper mixtures, are essential to proper planning. The nature of the two solutions permits penetration into fine pores, and tests have shown that the saline solution will penetrate any strata reached by the sodium silicate. A precipitated silicic gel cements the sand grains to form a stable stratum.

After a section had been stabilized, tunnel crews advanced the face 6 to 8 ft., leaving a 2-ft.-thick plug of firm ground in advance of the face. The material was excavated easily with the pneumatic clay spades, and no blasting was necessary. Stabilization and excavation were repeated until the quicksand area in the upper tube was passed, and normal tunnelling was resumed.

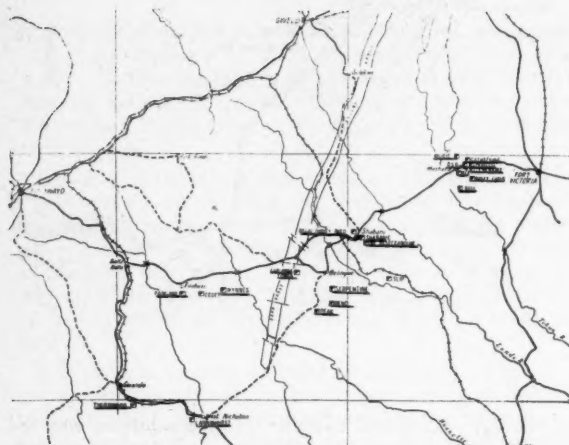
The stabilizing crew began work at the lower face after it was possible to resume the normal tunnelling in the upper tube. It was first necessary to repair a 14-ft. section of the tunnel where a "mud run" and the resultant pressures had badly damaged the steel lining. As the ground around the damaged section was stabilized, damaged liner plates were removed and replaced. The face area was then stabilized by repeating the cycle of injection stages and the two headings met, holing through a plug of stabilized ground.

## Conclusions

The difficult tunnelling at Tioga No. 2 mine was completed through the use of chemical soil solidification after grouting failed to solve the problem. Chemical soil solidification is not a cure-all for all stabilization problems, since clays and fine silts cannot be stabilized as yet. Where rapidly flowing ground waters are present, special precautions must be taken to prevent the chemicals from being carried off before becoming effective. In areas containing large crevices or voids, the cost may become prohibitive. Cement grouting of the larger crevices first are recommended, followed by chemical solidification in such areas. Careful planning, including preliminary laboratory tests, and experienced supervision are recommended for satisfactory results.



## Asbestos in Southern Rhodesia



**A**SBESTOS is now the leading mineral in value of output produced in Southern Rhodesia. The industry is an old-established one, and is confined to a belt 150 miles long and 40 miles wide, lying west and south of Fort Victoria. There is one exception, in the Ethel mine, 90 miles north of Salisbury. The main occurrences are indicated on the map, and are seen to strike across the southern end of the Great Dyke.

The largest deposits occur near Shabani, where the main mass of asbestos-bearing serpentine (ultra basic rock) occupy an area some ten miles long and from one to two miles wide, completely surrounded by granite. The asbestos deposits in their workable sections are lenticular in form and have been proved by drilling to considerable depths. Only rock containing more than 1 per cent of fibre is considered payable.

Some forty miles east of Shabani, another area of serpentines contain payable quantities of asbestos fibre. The fibre is of different quality to that of Shabani, being somewhat

Group and Company	Mine or Claim	1958 Production (Short Tons)	Remarks
<b>MASHABA AREA</b>			
TURNER AND NEWALL LTD. ... ..			Controls 75 per cent of Southern Rhodesian asbestos production.
Rhodesian and General Asbestos Corporation	Gaths	24,829	
Rhodesian Asbestos Ltd.	Kings		
	Temeraire	14,385	Purchased from Johns Manville Group during 1958.
	Shamala		Swiss Group. Parent Company: Asbestos Investments (Pty.) of Johannesburg.
SCHMIDHEINY GROUP			
Boss Asbestos Mines (Pvt.) Ltd.	Boss	4,134	Run from Johannesburg. A. Walther, consulting engineer, is connected with Everite Pipes, etc. Rumour of new plant increase.
ROSS MCINTYRE AND PARTNERS (RHOD.) (PVT.) LTD.			Run under Section 161 of Company's Act Deed of Agreement by W. M. Russell (director of Commonwealth and Overseas Asbestos Corporation, Johannesburg).
	D.S.O.	2,635	Small ore reserve?
	Murie	1,268	Tributed from Mashaba Rhodesian Asbestos Co. Ltd.
	Rosey Cross	850	
	Bluebird		Owned by Portuguese Asbestos Cement interests. Run from Beira.
<b>"PORTUGUESE" INTERESTS</b>			
Kilmarnock Asbestos Mines Ltd.	Princess	777	
"BAIRD" GROUP	Rex	1,967	Owned by U.K. coal interests. Run by S.A.G.I.T. in Salisbury. (See Peak.)
<b>SHABANI AREA: BELINGWE/GWANDA</b>			
TURNER AND NEWALL LTD. ... ..			
Rhodesia and General Asbestos Corporation	Shabanie	53,054	(See Gaths, Kings, etc.)
African Asbestos Mining Co. (Pvt.) Ltd.	Nil		
	Croft	3,224	
SCHMIDHEINY GROUP ASBESTOS INVESTMENTS (PTY.) LTD.			Swiss capital, run from Johannesburg. (See Boss.)
Vanguard Asbestos Mine (Pvt.) Ltd.	Serpentine	8,212	Reports of significant increase in plant for production of short fibres.
Pangani Asbestos Mine (Pvt.) Ltd.	Pangani	316	Being developed.
ROSS MCINTYRE AND PARTNERS (RHOD.) (PVT.) LTD.			(See D.S.O., Murie, etc.)
	Gurumba Tumba	426	Leased from S.R. Chrysotile Corp.
	Regal	94	Leased from Mashaba Rhodesia Asbestos Ltd.
	Slip	967	Leased from Rhodesia Monteleo Asbestos Ltd.
	Benda	908	Australian owned.
BEND ASBESTOS (PTY.) LTD.			
"BAIRD" GROUP			
Peak Mine (Pvt.) Ltd.	Peak	565	(See Rex.)
LANNINGHURST ASBESTOS LTD.	Lanninghurst	288	Producers of high-grade spinning fibre.
DOMINION BASE METALS (PVT.) LTD.	Wynnes	3,986	
LONGWOOD ASBESTOS MINING CO. LTD.	Recompense	60	Prospect only.
THORNWOOD ASBESTOS (PVT.) LTD.	Thornwood	1,423	
P. AND M. CORPORATION (PVT.) LTD.	Silver Oak	17	Prospect only? Reported opening.
<b>SALISBURY AREA</b>			
Ethel Asbestos Ltd.	Ethel	1,440	

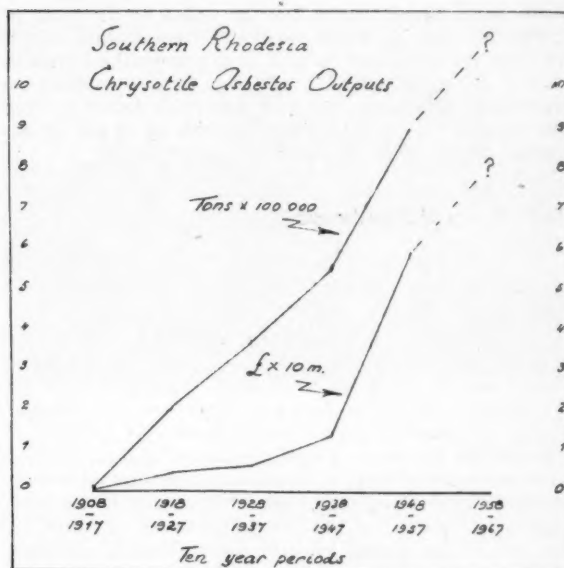
harder and more difficult to mill. Smaller asbestos deposits occur in the serpentines lying east and south of Filabusi, in the Gwanda area, and in West Nicholson area.

The mines producing asbestos are controlled by large groups. Production in 1958 was distributed as follows:

	Short Tons	Percentage
Turner and Newall Group ...	95,492	76.77
Schmidheiny Group ...	12,662	10.18
"Independent" producers (7 mines)	7,460	6.00
Ross McIntyre Group ...	6,240	5.01
Baird Group ...	2,532	2.04
<b>TOTALS</b> ...	<b>124,386</b>	<b>100.00</b>

From value of production: £8,435,885.

Neither the value nor grades of the fibres produced by individual mines are made public. The fibre market is said to be highly competitive, a fact which is borne out by the small number of individual producers which have survived over the years. It is interesting to note that practically every mine is tied directly or indirectly to a consumer. For this reason, it is impossible to obtain any information about ore reserves or production plans, other than that indicated in the table opposite.



## Microbiological Processes in Mining

THE study of microbial processes has been greatly intensified in the last decade and there are currently a number of potential applications of such processes under investigation which embrace diverse industries and overlap the fields of several other branches of science. One new field which has been entered by the microbiologist is that of metallurgy and bacterial leaching processes which promises to be of considerable economic significance to the mining industry. Most of the work on microbial metallurgy has so far been carried out in North America but the Chemical Research Laboratory of the D.S.I.R. is undertaking similar studies in this country and research programmes are being drawn up in many countries.

Published work on the microbiological extraction of metals is reviewed below, from which it can be concluded that the mineral engineer may well be adding the application of microbiology to his traditional methods of ore treatment in the same way as in recent years science has provided him with new tools based on radiometrics, ionic exchange, electrostatics and ultrasonics, to quote only a few of the complex scientific aids to the art of mineral treatment.

In the same way the exploration engineer has been accumulating new techniques in which a knowledge of sciences not purely his own are essential, electromagnetics and again radiometrics are obvious examples. Geochemistry is perhaps the most pertinent technique to mention here as soil microbiology is already contributing to our knowledge of geochemical processes.

The growing interest in these studies is evidenced by the growth in membership from 100 to 500 in 10 years of the U.S. Society of Industrial Microbiologists. It is also interesting to note that Dr. Walter Ezekiel of the U.S. Bureau of Mines is a founder member of this organization.

### Microbes and the Metallurgist

Pioneer North American Research into microbial methods of metal extraction was carried out by a group of investigators at Brigham Young University, Provo, Utah,

and was concerned with the microbial conversion of relatively insoluble oxide-sulphide ores into sulphates which were readily amenable to leaching.

The organisms used in the laboratory experiments were isolated from the acid effluents issuing from the waste dumps at Bingham Canyon mine, Utah, where for some years the leaching of ore below the cut-off grade of 0.4 per cent copper has been carried out. The appearance of copper (to the extent of 12 lb. per 1,000 gals.) in the leaching water has always been assumed to be due to the chemical formation of sulphuric acid, but was proved at Provo to be due to microbiological processes which increased by 10 to 20 times the rate at which pyrite is oxidized to soluble ferric iron and sulphuric acid. Unbeknown, microbial metallurgy has been practised at Bingham Canyon (and elsewhere) over a long period but the recognition and investigation of these processes may lead to important commercial developments.

The work begun at Provo has been continued by members of the original research team at the research centre of the Kennecott Copper Corporation and the U.S. patents on the process obtained by the Corporation were briefly described in *The Mining Journal* of September 5, 1958.

Several strains of bacteria have been identified in the mine waters of the Bingham Canyon and Chino mines and mutations have been produced which are able to live and multiply in relatively high concentrations of dissolved copper. Processes have been developed for the extraction of copper, molybdenum and zinc from sulphide or sulphide-oxide ores, and which upgrade iron-chromite or iron-titanium materials by leaching out the iron.

The bacteria involved in these processes are similar organisms to *Thiobacillus-ferrooxidans* which had been isolated from the acid mine waters of coal mines in the Eastern States of the U.S. Such bacteria are capable of oxidizing ferric iron to ferrous iron much faster than by atmospheric aeration. In cases where the acid formed is used up in the leaching process without a corresponding decrease in iron content the ferric sulphate produced may hydrolyse precipitating the ferric salt and liberating more acid. Where insufficient iron is present sulphuric acid may

have to be added. Iron may be added in the form of pyrite and bled off where necessary. Temperature control of these processes must be such as to prevent the immobilization of the bacteria and 40 deg. C. is considered an operating maximum. Bacterial activity is found to drop off rapidly below pH 1.5 but above this up to pH 2.5 excellent results are obtained.

### Wide Range of Experiments

Currently, work is proceeding on the addition of nutrients such as nitrogen in the form of nitrate of ammonium ions to increase bacterial activity.

Similar work to the above has been carried out at the Eastern Park Experimental Station of the U.S. Bureau of Mines initially using pure strains of organisms from the 4,360 catalogued by the American Type Culture Collection such as *Thiobacillus thio-oxidans*, *Thiobacillus novellus*, or *Thiobacillus thio-parus*. Direct application of these cultures to sulphide ores of copper, cobalt and iron resulted in negligible extraction and the bacteria had first to be acclimatized to the toxicity of the ores. Eventually, yields of 70 per cent of the copper and iron were obtained. Sulphur addition to stimulate bacterial growth is considered necessary and the application of these methods to the extraction of oxide ores by adding poor quality sulphur is being investigated.

The British Columbia Research Council is investigating bacteriological processes with the aim of exploiting metal deposits in virtually inaccessible mountain districts. The oxidation processes occurring in coal mines mentioned above would be encouraged by the dumping of sulphur and is hoped to result in enhanced leaching of the metals as sulphates. The metals could then be extracted from rivers and streams lower down the mountain slopes where access would be easier.

Also undertaking microbiological research in the U.S.A. is the Bureau of Mines Electrometallurgical Experiment Station which is working on the extraction of manganese from low-grade ores. Whilst studies are at an early stage, experiments on four types of low-grade ore have given recoveries averaging 97.5 per cent.

Parallel researches to those described above are being government-sponsored in South Africa and other Commonwealth countries and it has recently been announced that a programme of investigation into microbial metal extraction and similar processes is to be carried out at Walvis Bay, South West Africa, where microbiological activity is presumed to give rise to the periodic sulphurous eruptions off the coast.

### Bacteria in Coal Mines

Mention has been made above of the work on sulphur-oxidizing and iron-oxidizing bacteria present in acid mine waters. Contrary to the aims of microbiological metal extraction much of this research has been with a view to preventing acid production in mine waters and the subsequent pollution problems which arise in disposing of the effluents from bituminous coal mines. Investigators at the Mellon Institute in Pittsburgh have concluded that bacteria are, in fact, relatively unimportant in the production of acid which is derived from pyrite and marcasite in the coal. The problem is a serious one in some areas and pollution by acid continues when mining ceases.

At the Synthetic Liquid Fuels Laboratory at Bruceton, Pennsylvania, the U.S.B.M. is studying the microflora associated with coal and the enzymic degradation of coal which, it is thought, may overcome the problem of undesir-

able changes in the structure of coal by normal, but drastic, chemical treatments. The use of bacteria in breaking down coal holds promise of releasing intermediate chemical combinations and new useful coal derivatives.

The Bureau is also trying to develop a strain of bacteria which, it is hoped, will feed on the gases formed underground in collieries.

### Microbiology and the Petroleum Industry

A number of aspects of microbiology are attracting the attention of the U.S. petroleum industry at the present time, although much of the pioneer work in this field of study was carried out by Dr. Claude E. ZoBell for the American Petroleum Institute as early as 1942. His studies indicated that certain sulphate-reducing bacteria assisted in the liberation of oil and the application of this discovery in oil prospecting and in the recovery of oil from shale and wells is the subject of intensive present research.

At the Petroleum and Oil Shale Experiment Station, Laramie, Wyo., the U.S. Bureau of Mines is conducting fundamental studies of the structures constituting oil shale. Oil is normally liberated from shale by retorting or distillation but the oil produced is of poor quality and the processes are usually commercially unfeasible. The U.S.B.M. researches have now isolated a number of micro-organisms which thrive on oil shale as a source of hydro-carbons and release petroleum products from the inorganic matrix. The organisms are Gram-negative rods and by using ultraviolet rays to bombard cultures of these bacteria it is hoped to speed up mutation and breed a suitable strain for oil release which is also hardy enough for commercial use.

At the Marine Biology Division of the University of California's Scripps Institute of Oceanography, Dr. ZoBell is studying a bacterial organism, *desulfovibrio halohydrocarbonoclasticus*, with which he has succeeded in liberating oil from samples of oil sands, oil sediments, and the Athabasca tar-sands. The bacteria, by creating acids which burn open the pores in oil sands, detergents which thin the oil, and carbon dioxide which increases the gas pressure within the oil formation, speed up the flow of oil and would recover oil that cannot be won by present methods. Field tests of Dr. ZoBell's researches are believed to have been made but no results have been published.

The oil industry is already working on this topic and the U.S.B.M. has initiated a complementary study of the detection and control of bacteria in the injection water used to assist the secondary recovery of oil from wells. At present, water injection is the most efficient method of moving oil into the bore of an oil well, from 10 to 15 bbl. of water being injected for every bbl. of oil recovered. Deposition of solids in the sand pores raise the injection pressures required beyond practical limits and a number of sulphate-reducing bacteria and other micro-organisms cause trouble by agglomerating and forming slime on the sand surfaces. A sub-committee of the American Petroleum Institute has been set up to standardize the procedure for examining the bacterial content of injection water.

At the instigation of Dr. ZoBell and co-workers in the microbiological field, a survey of soil bacteria in Antarctica was included in the U.S. national programme for the International Geophysical Year. The microbiological survey was to be evaluated with regard to the possible existence of oil and coal deposits in the Antarctic.

Most of the research projects described above are at too early a stage to assess their commercial possibilities. There is, however, a growing interest in microbiological investigations and a current expansion of activity both in the U.S. and other countries which may well yield further developments of interest to the mining and petroleum industries.



## Machinery and Equipment

### Remote Control for Rotomotors

To the complete range of Holman Rotomotors, described in our issue of March 27, 1959, has been added control equipment manufactured by Maxam Power Ltd., one of the Holman Group of Companies. This equipment controls the forward and reverse operation, in addition to controlling a cylinder-operated brake on hoists and winches, etc. The lever controls can be conveniently located on a panel at distances up to 200 ft. from the Rotomotors.

The remote control equipment for each Rotomotor unit comprises a hand-operated lever valve situated on the control panel and, in the motor, a rack, actuated by duplex pistons situated at each end, which engages a pinion on the reversing valve. In the neutral position compressed air is applied to both ends of the duplex pistons, and the reversing valve shuts off the air supply to the vanes of the rotor. When the "forward" position is depressed pressure is released from one side of the duplex piston. Being no longer a balanced air pressure the duplex piston and rack moves across, thus turning the reversing valve. This movement allows air to pass to the vanes of the rotor. Choice of "reverse" hand-operated lever valve position moves the duplex piston into reverse which changes the direction of air to the rotor.

#### COAL-HANDLING BLADE

Big production is claimed for a new coal-handling blade announced by International Harvester for the Doncaster-built BTD-20 124 b.h.p. tractor. This new item of equipment shows a complete move away from the conventional design of U-shaped blade commonly used in the industry. In designing the new unit, the manufacturers have concentrated on retaining the rolling action of the tra-

ditional U-blade while increasing the gathering effects of wing-pieces. This has been achieved by redesigning the basic International B-20G-2 Bullgrader blade, to include a spill-plate and, finally, adding wings on either side which are almost at right angles to the blade instead of sloping in towards the centre. The effect achieved is to roll the coal almost exactly as one would roll up a carpet. Side spillage is negligible while the big load rolls easily along with minimum effort from the tractor.

The coal-handling blade is 13 ft. 11½ in. wide (including spill plates) and 53½ in. high to the top of the spill-plate. The side extensions or wing-pieces project 12 in. from the face of the mould-board. It is mounted on the regular International Bullgrader "C" frame and is controlled hydraulically. Recent production tests with the B-20G-2 coal-handling blade revealed a handling rate of 358 t.p.h. on a reclaiming operation.

The coal-handling blade is 13 ft. 11½ in. wide (including spill plates) and 53½ in. high to the top of the spill-plate. The side extensions or wing-pieces project 12 in. from the face of the mould-board. It is mounted on the regular International Bullgrader "C" frame and is controlled hydraulically. Recent production tests with the B-20G-2 coal-handling blade revealed a handling rate of 358 t.p.h. on a reclaiming operation.

#### TUNNELLING FOR WATER

The contract for two separate tunnelling undertakings by the Malta Water Board was won by John Howard and Co. Ltd. in the face of strong international competition. Consulting engineers are Binnie, Deacon and Gourlay.

Two shafts, a working and a pumping shaft, each 9 ft. 6 in. dia., were sunk to

220 ft. All the tunnels were drilled for blasting by CP type 327 rotary coal drills, rubble being removed from the face by a compressed-air operated Eimco over-loader and loaded into jubilee tipping wagons hauled to the foot of the working shaft by a B.E.V. electric locomotive.

Rubble is discharged from the tipping wagons into a skip and is hoisted to the surface by a 5-ton capacity A.C.E. hoist mounted on a tower at the shaft head. This is electrically operated through a Holroyd reduction gear from a 65 h.p. 440-volt 3-phase motor. The unit includes a Dewhurst magnetic brake. Elsewhere, three Lee Howl multi-stage pumps are installed, each capable of maintaining an output of 385 g.p.m. against a 360 ft. head. They are direct coupled to 81 b.h.p. Brush electric motors.

The electrical power supply is provided by a series of 88 b.h.p. McLaren-Brush diesel driven generator sets. Compressed air power for the tools at the working faces, the Eimco over-loader, and other requirements, including a CP 77 air operated pump, which keeps the bottom of the working shaft clear, is provided by a battery of three portable air compressors. These comprise two Consolidated Pneumatic type 600-RO-2 rotary power vane compressors, powered by Rolls-Royce C6NFL diesel engines, and a CP 500 c.f.m. reciprocating unit powered by a Ruston 6 VQ diesel engine.

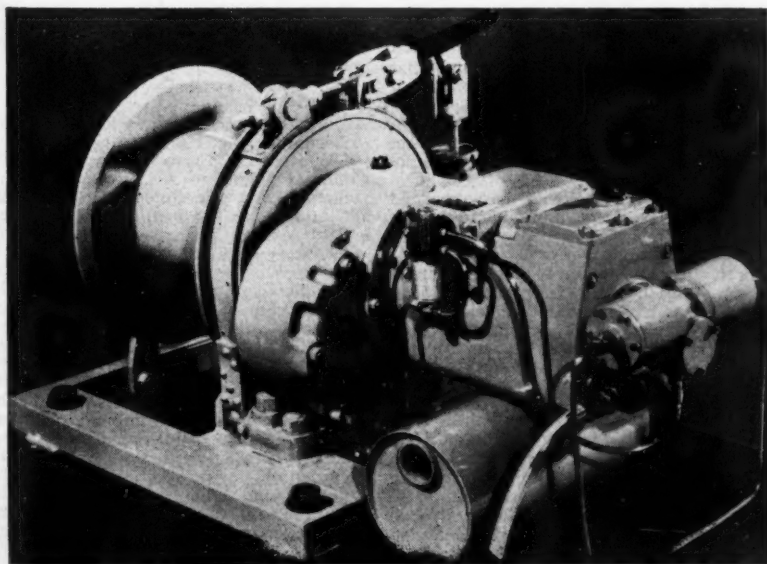
#### NEW TIMBER IMPREGNATION PLANT

A new timber impregnation plant has recently been installed in the Clun Valley by Clun Valley Sawmills Ltd. Timber will be treated there with "Tanalith" C and "Pyrolith" preservatives and fire-retardant chemicals.

The new plant has two 5,000 gal. rectangular tanks for storing "Tanalith" C and "Pyrolith". A special feature is that all pipes and cylinders drain into one sump for re-collection by vacuum. Mixing tanks have been connected to the exhaust of the vacuum pump for agitation. The plant is capable of handling three standards of timber a day.

#### APPROVED IN W. GERMANY

As the result of technical negotiations and tests extending over four years, six of the principal models of Nu-Swift pressure charge operated fire extinguishers have now been approved by the West German Government. This is the first time that British-made extinguishers have been approved for sale and use in the Federal Republic of Germany.



# MINING

## MISCELLANY

Although Colombia's tempo of industrial activity slackened in 1958, the national steelworks at Paz del Rio increased output of steel products to 95,000 tons in the year. The steelworks is now in the process of purchasing a sintering plant and rolling mill equipment for the production of sheet and tin plate.

It has been reported that the Jewell Ridge Coal Co., United States, together with an American investment company, are negotiating with certain Japanese steel companies for the establishment of a joint coal mining enterprise in Alaska.

A team of sixteen Japanese specialists in geological surveys and dam construction has left for the survey of the Mekong River and its tributaries, being carried out under ECAFE auspices. The cost of the survey to the Japanese Government was said to be \$240,000.

Mr. H. Oppenheimer, chairman of De Beers Consolidated Mines, has announced that a new research company, the Consolidated Diamond Development Co. Ltd., has been formed in Canada by South African diamond interests and Engelhard Industries to investigate new industrial uses for diamonds. The main object of the new company, which will have an initial capital of £100,000, will be to expand and develop the uses of natural diamond abrasives for the benefit of wheel makers and other users of the material, to whom the results of experimental work will be made available.

A luncheon was given by a delegation from the New York Society of Security Analysts at Grocers' Hall, London, last Monday. Prominent financial and business figures were invited. Mr. Ralph Rotnem, of Harris, Upham and Co., took the chair, and Sir Oscar Hobson, financial editor of the *News Chronicle*, spoke on behalf of the guests. Prior to the luncheon, which was arranged for the New York Society of Security Analysts by the American Chamber of Commerce in London, the delegation visited the London Stock Exchange.

It is reported from Jerusalem that the Israeli authorities want the copper refinery which the Ambash Engineering Corporation proposes to set up at Tantura on the coast between Haifa and Tel-Aviv to be erected at another site, near Akko, or Ashdod.

Rich iron ore deposits over an area of 100 square miles have been found in Ratnagiri district of Bombay state. A recent extensive geological survey has revealed the existence of iron ore in Ratnagiri district and bauxite in Radhanagiri, near Kolhapur. Large quantities of limestone and gypsum have also been found in Ratnagiri district.

What is claimed to be the world's biggest iron ore mine is being sunk in the Krivoi Rog Basin, South Ukraine. The mine will go into operation in 1961 to produce 7,400,000 tons of commercial

ore annually—about half the annual iron ore output of Sweden or Canada.

The General Services Administration has announced that 22,423 s.tons of synthetic cryolite, now held in United States Government inventory, will be offered for public sale. The cryolite, primarily used in the processing of aluminium, but also in the glass and insecticide industries, has been declared surplus to the national stockpile of strategic materials. As a surplus material, it is eligible for immediate disposal.

Results of extensive field and laboratory studies of the occurrence of uranium in phosphates have been published by the U.S. Geological Survey. The study is part of the Survey's research programme on the occurrence and distribution of minerals and mineral fuel resources. Many of the world's large phosphate deposits contain important quantities of uranium, and United States industry is now recovering uranium as a by-product of superphosphate fertilizer production.

A new State Coalfields Department (Yacimientos Carboníferos Fiscales) has been founded in Argentina for the development of the country's coal resources. It is hoped, with the aid of French investment, to develop the Rio Turbio mines in the far south.

The year 1958 was a record one for aluminium production in Norway. Output totalled 120,000 tons compared with 96,000 tons in 1957. A new aluminium works at Mosjoen went into operation and the works at Høyanger were extended. The State-owned Aardal and Sundal works signed a contract with Aluminium Union Ltd. for the supply of aluminium oxide against payment in aluminium for the next twenty years. Plans were approved by the Storting for the further development of production facilities at Aardal.

The Japanese steel mission in India has made a proposal to the Government of India that the steel industry of Japan will be prepared to purchase 4,000,000 tons of iron ore from India per year from 1966 onwards. The leader of the mission, Mr. S. Nagaho, president of Fuji Iron and Steel Mills of Japan, has expressed willingness to buy this quantity from Madhya Pradesh, in addition to 2,000,000 tons of iron ore which the Japanese industry has undertaken to buy from India from 1964 onwards from the Rourkela area. Discussions have also taken place about the export of metallurgical coal and pig iron from India to Japan in the near future. The total quantity of iron and steel scrap exported to Japan from India in 1958 was 105,000 tons, worth Rs.16,500,000.

Colombia's production of gold and silver in 1958 showed a decrease from the outputs of the previous year. In 1958, the country produced 315,291 oz. troy of gold (1957, 325,130 oz. troy) and 86,986 oz. troy of silver (1957, 106,493 oz. troy).

Production of pig iron in Norway increased by 15,000 tons to 260,000 tons in 1958. Two new electric furnaces came into operation, one at the State-owned Norsk Jernverk at Mo, and the other at Bremager. Norsk Jernverk, which continued to run at a heavy loss, dropped plans to erect a pipe mill and a heavy plate mill, but put forward plans for the extension of the sheet mill at Bergen.

### PERSONAL

Dr. Charles L. Christ, a physicist with the United States Geological Survey, has been selected for a Rockefeller Public Service Award for 1959. A member of the Geological Survey since October, 1949, Dr. Christ is in charge of the unit responsible for working out crystal structures as a means of systematic classification of minerals.

Sir Ashley S. Ward, LL.D., the Sheffield industrialist, died on March 26, at the age of 81, after a short illness. Sir Ashley was president of Thos. W. Ward Ltd., Albion Works, Sheffield, chairman of the Park Gate Iron and Steel Co. Ltd., Rotherham, vice-chairman of Laycock Engineering Co. Ltd., Sheffield, and a local director of the National Provincial Bank Ltd. He was knighted in 1958.

Mr. A. R. Neelands, chairman of the Cementation Co. Ltd., flew to the Middle East on April 6 on a routine business tour. He will visit Cementation Co. contracts in Iran and Iraq. Mr. Neelands will be returning to this country during the latter part of this month.

The Export Credits Guarantee Department announces that the President of the Board of Trade has appointed Mr. Maurice Laing an additional member of the Department's Advisory Council. Mr. Laing is managing director of John Laing and Son Ltd. and chairman of the Export Group for the Constructional Industries.

### CONTRACTS AND TENDERS

#### Formosa

Ten tonnes structural steel bars, two electric capacitors, one double-drum slush hoist motor, two mine locos, and 1,500 ft. rubber hose. Issuing authority and bids to Central Trust of China, Purchasing Department, 68 Yen Ping Nan Road, Taiwan (Formosa). Closing date, April 29, 1959. Ref. ESB/8163/59. Telephone inquiries to Chancery 4411, extension 354.

#### Pakistan

Fourteen sets borehole turbine pumps, 200 g.p.m. at 130 ft., driven 380 v.-400 v. a.c. 3-phase 50-cycle electric motor. Bids to Director-General of Supply and Development, Chittagong. Closing date, April 20, 1959. Ref. ESB/8602/59. Telephone inquiries to Chancery 4411, extension 738 or 771.

Following negotiations between Dr. I. H. Usmani, for the Government of Pakistan, and Powell Duffryn Technical Services Ltd., a contract has been agreed between the government and the company under which the latter will carry out a survey of Pakistan coalfields. The main objectives are to improve operating techniques at existing mines, and to recommend what further work should be carried out for prospecting new areas, by drilling and other means, and for the development of the industry, including the better grading of coal and the manufacture of briquettes.



## Metals and Minerals

## Quicksilver's Firmer Trend

A few weeks ago, there was little indication of any probable upturn in quicksilver prices. February closed with the London ex-warehouse price still at £74, at which level it had remained following a reduction from £78 in November last year. In New York, the progressive decline in quicksilver prices resulting from the termination of the United States Government purchase programme had been arrested, and a firmer tendency had become apparent. Prices still appeared delicately poised, however, and it was generally considered in London that the resistance to further drifting was due primarily to the tenacity with which Spain and Italy continued to hold out for £80 per flask f.o.b. At £74, it was pointed out, the London spot price seemed high in relation to the shipment price of Mexican metal, which was currently being mentioned at about £69 per flask c.i.f.

Latterly there has been a steady rise in the quicksilver price, both in London and New York. On April 1, the quotation metal for immediate delivery ex-warehouse London moved up to £78 per flask from £77, at which point the price had risen £4 in about three weeks. In New York, the price continues to show strength and is currently \$230 to \$235 f.o.b. New York, which compares with \$218 to \$222 as recently as mid-March.

As with previous advances, the current movement is felt in the trade to reflect more the shortage of physical metal on the spot rather than any improvement in the rate of demand. The present situation appears to have its genesis in seasonal difficulties in Mexico, where production was reported to have been quite substantially affected by rains. This has doubtless stimulated buying interest on the part of consumers who had let their stocks run down in the expectation of cheaper supplies from Mexico, which have not materialized.

Stocks of metal in both Spain and Italy, especially the latter country, are plentiful. Even so, both these countries continue to quote £80 per flask f.o.b. with varying discounts for quantity lots. This, of course, appears to set an upper limit, at any rate for the time being, to the scope for any further rise in price. At the same time, rumours of rising production costs in Mexico suggest the possibility that offerings from this source might in future constitute less of a threat to market stability than seemed probable when the termination of the United States purchasing programme was announced.

It is interesting to note that, according to the Central Statistical Office, Italy's quicksilver exports amounted last year to only 393 tonnes, which compares with 992 tonnes in 1957 and 2,585 tonnes in 1956.

## JAPAN PLANS LARGER MANGANESE EXPORTS TO U.S.

Japanese ferroalloy makers have worked out an export plan for their products in the new financial year which started on April 1. They are planning

to export 111,800 tonnes of the products, worth \$29,000,000, during the year compared with 86,000 tonnes in the year just ended.

The amount does not include shipments to the Commodity Credit Corporation of the United States for its strategic stockpile in a barter deal against American surplus agricultural products. A total of 13,300 tons of ferrochrome is to be delivered to the United States during the period from January to December, this year, in the barter contract. In addition, the manganese producers are also considering a plan to sell about 50,000 tons of ferromanganese to the CCC in another barter deal with American surplus food, assuming that ferromanganese may be included again by the United States Government in the strategic materials importable in barter deals with surplus food.

## U.S. LITHIUM DEAL

A five-year option on lithium mining properties in North Carolina has been granted to Texas Gulf Sulphur Co., under an agreement with Basic Atomics Inc. The agreement includes a five-year option on patent rights on a new process for the recovery of lithium from spodumene bearing ores and concentrates.

## NEODYMIUM IN PRODUCTION

Neodymium, a metal which appears capable of increasing the heat resistance of magnesium for aircraft and missile applications, and which may also have applications in steel and aluminium alloys, is now being produced in industrial quantities by the Nuclear Corporation of America.

Of the rare earths, neodymium has been commercially available previously only as an oxide or salt. The quantities of pure metal available have been so small that detailed study of its properties and potential applications has been impossible.

Neodymium is one of the more abundant rare earths. Now that an industrial process for extracting and reducing it to 98.99 per cent purity has been perfected, adequate quantities for relatively large-scale use could be made available, states the Nuclear Corporation.

## NEW ALUMINIUM PLANTS

A major new plant to produce aluminium alloys has been brought into production by American Smelting and Refining Co., at Alton, Illinois. With a rated capacity of 36,000 s.tons of alloys annually, this plant is reported to be the largest single unit designed and constructed solely to refine and alloy secondary aluminium. The Alton site was selected because it is favourably located in relation both to the availability of raw material and to major alloy consuming centres.

Specifications will be ready by July for the £A1,500,000 expansion of the alumi-

nium plant at Bell Bay, Tasmania. The work is expected to increase output from 12,000 to 16,000 tons of aluminium ingots a year.

## U.S. ANTIMONY STATISTICS

United States domestic smelter output of antimony during 1958 at 9,200 s.tons was nearly 20 per cent below that of 1957, reports the Bureau of Mines, U.S. Department of the Interior. Production during the fourth quarter totalled 2,400 tons. This quantity was 7 per cent less than that of the third quarter, but 6 per cent greater than the average of the three preceding quarters of the year.

Preliminary tabulations indicate that industrial consumption amounted last year to 10,600 s.tons (12,389 tons in 1957). Use in battery grids, anti-friction bearings, cable sheathings, type metal, and other metallic products, accounted for 58 per cent of the total consumption. Stocks of antimony held by consumers, dealers, and smelters, declined from 7,400 tons on January 1 to 6,500 on December 31—a 12 per cent drop during the year.

Total receipts of foreign antimony in 1958 were 8,700 tons—a 42 per cent decline from the 1957 total. Chief contributors of ore and concentrate in quantitative order were Mexico, Bolivia, and Union of South Africa. As in previous years, most of the metal imports originated in Yugoslavia, United Kingdom, Belgium-Luxembourg. Imported oxide and sulphide came from the U.K., Belgium-Luxembourg, and W. Germany.

A slight upward pressure in prices for antimony ore c.i.f. Continent has been discernible lately. In the past month or two, both the United States and Japan were reported to have been paying higher prices for Bolivian ore, some of which might otherwise have been available for the Continent. The United Kingdom market, however, remains steady and featureless, with imports from Iron Curtain countries seemingly restricted by the increased duty on imported regulus, which currently stands at £40 a ton. Most of the United Kingdom's requirements are covered by long-term contracts and basis 60 per cent ore remains unchanged at from 19s. 6d. to 20s. 6d. per 1,000 unit c.i.f.

## UPGRADING STOCKPILED MOLYBDENITE

The General Services Administration of the United States (G.S.A.) has asked that proposals be submitted to it not later than May 14 to produce molybdenic oxide from United States Government owned molybdenum disulphide (molybdenite), now held in the national stockpile of strategic materials. After processing, the molybdenic oxide must contain 3,000 s.tons of molybdenum. The conversion is part of the programme announced by the agency last autumn to upgrade some of the materials in the stockpile by converting them from raw to processed form.



# COPPER • TIN • LEAD • ZINC

(From Our London Metal Exchange Correspondent)

Except for an unexpected collapse in the copper market on Tuesday, prices have remained without notable alteration since last week, with a better undertone developing in the lead and zinc markets.

## L.M.E. COPPER PRICE STUMBLES

The sudden slump in the copper price is all the more inexplicable as consumption in the world remains at a high rate, and during the week the Spanish Government has been in the market, the new licensing period in India has commenced, and the Japanese Government has announced it will grant import licences for 3,700 tons of electrolytic copper and copper alloy to make up the supplies lost by the recent strike in that country. It was, therefore, not surprising that the price recovered sharply almost immediately. The level price between prompt and forward metal remains unchanged, although stocks in official warehouses showed their first fall for some weeks—of 225 tons to a total of 9,641 tons.

Following the sharp break in the London market, customs smelters in the United States reduced their intake price for No. 2 scrap from 28 c. per lb. to 27½ c. per lb., but their selling price of 34 c. per lb. has been maintained as it is understood that order books are full and the intake of scrap still at a low volume. The primary producers report good business at 31½ c. per lb., and most report that there is no more metal available for April. Orders for May are satisfactory.

There is still no news of the existing position at Anaconda's Butte mine,

where there is a possibility of a strike of railroad workers which would stop the flow from the mine to the refinery. Apart from this, labour relations throughout the producing countries have taken a turn for the better, with the recent agreement in Rhodesia about methods of negotiation and the action of the Chilean Government in including those employed in the copper mining industry in their Bill designed to provide compensation for rises in the cost of living.

## IS BUFFER STOCK SELLING TO U.S.?

The tin market has remained steady, although quotations in the East have tended to drift downwards, probably due to increased selling pressure at the beginning of a new quota period. The contango in London continues in spite of a further fall in official stocks of 570 tons to a total of 10,179 tons. This means that stocks in official warehouses have fallen by about 6,000 tons, and this has given rise to talk about whether the buffer stock is, in fact, being able to unload reasonable tonnages of tin direct to American consumers. There is little definite news on this point, although the figures seem to point to there being some substance in the story.

During March, which was the last month of the quota period, shipments of tin from Singapore showed a fall at 101 tons against 122 tons in February, whilst shipments from Penang showed a rise at 3,846 tons against 3,561 tons.

Agreement has been reported this week

on the United States barter contract with Bolivia for 5,000 tons of tin metal in exchange for surplus farm products. With Bolivia's present quota running at an annual equivalent of 19,125 tons, this outlet (entirely outside of the quota scheme) for an additional 5,000 tons will bring Bolivia's sales for this year to within 2,000 tons of her pre-quota rate of production of around 27,000 tons. Here is one country which is not suffering unduly from quota restriction, whatever may be the internal political and technical difficulties affecting her tin industry. One interesting point which has not yet been clarified is whether the ore under the barter agreement will be smelted in Texas or in Britain. Either way it will, of course, remain insulated from the market.

On Thursday morning, the Eastern price was equivalent to £815½ per ton c.i.f. Europe.

## LEAD-ZINC STEADIER—FOR THE MOMENT

Following the reduction in the United States lead quotation in the middle of last week, the London price has been steadier, probably due to technical considerations and an apparent lessening in the flow of metal to the United Kingdom, but this state of affairs is considered unlikely to continue and renewed pressure on the price is expected.

Now that the backwardation in the zinc market has been practically extinguished, prices have shown a slightly better tendency, but, as in the case of lead, the possibility of renewed pressure cannot be excluded, especially as during the week the Canadian zinc price was lowered by ½ c. per lb.

In February, the O.E.E.C. countries produced 46,296 tonnes of lead as compared with 51,166 tonnes in January, whilst the zinc produced totalled 64,071 tonnes against 69,672 tonnes in January. Both rates of production are still below those of the corresponding month last year.

In the United States, the Bureau of Mines' statistics show that during January, the new supply of lead totalled 96,500 s.tons, whilst only 88,400 tons were consumed. It is interesting to note, however, that imports during the month totalled 17,000 tons, approximately half the quota for the first three months of the year. Producers' stocks of refined lead increased to nearly 200,000 tons, whilst mine production showed an increase of 8 per cent over the December figure at a total of 23,500 s.tons of recoverable lead.

Closing prices were as follows:

## LONDON METAL AND ORE PRICES, APRIL 9, 1959

### METAL PRICES

Aluminium, 99.5%, £180 per ton	Iridium, £23/£25 oz. nom.
Antimony—	Lanthanum (98/99%) 15s. per gram.
English (99%) delivered, 10 cwt. and over £190 per ton	Manganese Metal (96% - 98%) £245/£250
Crude (70%) £190 per ton	Magnesium, 2s. 3d. lb.
Ore (60%) bases 19s. 6d./20s. 6d. nom. per unit, c.i.f.	Nickel, 99.5% (home trade) £600 per ton
Arsenic, £400 per ton	Osmium, £21/£23 oz. nom.
Bismuth (min. 1 ton lots) 16s. lb. nom.	Osmiridium, nom.
Cadmium 9s. 0d. lb.	Palladium, £6 10s./£7 10s.
Cerium (99%) net, £16 0s. lb. delivered U.K.	Platinum U.K. and Empire Refined £28 10s. oz.
Chromium, Cr. 99% 6s. 11d./7s. 4d. lb.	Imported £26/£27
Cobalt, 14s. lb.	Quicksilver, £78 ex-warehouse
Germanium, 99.99%, Ge. kilo lots 2s. 5d. per gram.	Rhodium, £41/£45 oz.
Gold, 249s. 2½d.	Ruthenium, £18/£20 oz. nom.
	Selenium, 50s. 0d. per lb.
	Silver, 79½d. f. oz. spot and 78½d. f'd
	Tellurium, 15s./16s. lb.

### ORES AND OXIDES

Bismuth .. .. .	30% 5s. 0d. lb. c.i.f.
Chrome Ore—	20% 3s. 3d. lb. c.i.f.
Rhodesian Metallurgical (semifriable) 48% (Ratio 3:1) .. .. .	£15 15s. 0d. per ton c.i.f.
" Hard Lumpy 45% .. .. . (Ratio 3:1) .. .. .	£15 10s. 0d. per ton c.i.f.
" Refractory 40% .. .. .	£11 0s. 0d. per ton c.i.f.
" Smalls 44% .. .. . (Ratio 3:1) .. .. .	£14 0s. 0d. per ton c.i.f.
Baluchistan 48% .. .. . (Ratio 3:1) .. .. .	£11 15s. 0d. per ton f.o.b.
Columbite, 65% combined oxides, high grade .. .. .	nom.
Fluorapat—	
Acid Grade, Flotated Material .. .. .	£22 13s. 3d. per ton ex. works
Metallurgical (75/80% CaF <sub>2</sub> ) .. .. .	15s. 0d. ex works
Lithium Ore—	
Petalite min. 3½% Li <sub>2</sub> O .. .. .	40s. 0d./45s. 0d. per unit f.o.b. Beira
Lepidolite min. 3½% Li <sub>2</sub> O .. .. .	40s. 0d./45s. 0d. per unit f.o.b. Beira
Amblygonite basis 7% Li <sub>2</sub> O .. .. .	£25 0s. per ton f.o.b. Beira
Magnetite, ground calcined .. .. .	£28 0s./£30 0s. d/d
Magnetite Raw (ground) .. .. .	£21 0s./£23 0s. d/d
Manganese Ore Indian—	
Europe (46% - 48%) basis 57s. 6d. freight .. .. .	nom.
Manganese Ore (43% - 45%) .. .. .	nom.
Manganese Ore (38% - 40%) .. .. .	nom.
Molybdenite (85%) basis .. .. .	8s. 11d. per lb. (f.o.b.)
Titanium Ore—	
Rutile 95/97% TiO <sub>2</sub> (prompt delivery) .. .. .	£31/£33 per ton c.i.f. Aust'n.
Ilmenite 52/54% TiO <sub>2</sub> .. .. .	£11 10s. per ton c.i.f. Malayan
Wolfram and Scheelite (65%) .. .. .	84s. 0d./89s. 0d. per unit c.i.f.
Vanadium—	
Fused oxide 95% V <sub>2</sub> O <sub>5</sub> .. .. .	8s./8s. 11d. per lb. V <sub>2</sub> O <sub>5</sub> c.i.f.
Zircon Sand (Australian) 65 - 66% ZrO <sub>2</sub> .. .. .	£14 ton c.i.f.

	April 2		April 9	
	Buyers	Sellers	Buyers	Sellers
COPPER				
Cash .. .. .	£250½	£250½	£244½	£244½
Three months .. .. .	£250½	£250½	£244½	£244½
Settlement .. .. .	£250½		£244½	
Week's turnover .. .. .	7,500 tons		11,525 tons	
LEAD				
Current ½ month .. .. .	£67½	£68	£68½	£68½
Three months .. .. .	£69½	£69½	£69½	£69½
Week's turnover .. .. .	6,050 tons		5,750 tons	
TIN				
Cash .. .. .	£782	£782½	£782	£782½
Three months .. .. .	£784½	£785	£784½	£785
Settlement .. .. .	£782½		£782½	
Week's turnover .. .. .	685 tons		385 tons	
ZINC				
Current ½ month .. .. .	£71	£71½	£71½	£71½
Three months .. .. .	£71	£71½	£71½	£71½
Week's turnover .. .. .	4,825 tons		5,500 tons	

## Mining Finance

## The Rush for Diamonds

Diamonds are still De Beers's best friend despite the great expansion that has taken place in the group's industrial and gold-mining interests. The record value of the business done by its Central Selling Organization in the March quarter must thus heighten shareholders' hopes that an increase in the dividend on the Deferred after the payment of 10s. per annum for eight successive years will at last take place on account of the current year.

The recovery in Western World diamond sales has, in fact, been quite remarkable. In the period of the United States industrial recession, which coincided with a cessation of American stockpiling of industrial stones, the quarterly turnover fell rapidly from £21,444,588 in the September quarter of 1957 to only £13,934,105 in the June period of 1958. Since then there has been a spectacular improvement. In the December quarter of last year, when the total traded was £20,246,615, the business

in gems reached its highest quarterly level ever of £15,327,135.

The March quarter figures, now published, show even better things. The total is a high record at £23,586,653. The gem component of this is at the new peak of £15,865,262, and industrial sales, at the sharply higher level of £7,721,391, are the best since the June quarter of 1952. What lies behind these boom figures which, if continued, would make 1959 an even better year than 1957, when the value of the sales of all classes of stones was a record at £76,772,112?

The business recovery in America is, of course, one important factor. But demand for gems is understood also to be strong in Continental centres and elsewhere. In these days of drifting monetary values, there is no doubt that diamonds as an investment have a considerable appeal, partly owing to the ease with which they can be stored or transported from place to place.

## LONDON MARKET HIGHLIGHTS

While the industrial share markets on the London Stock Exchange eagerly awaited the Chancellor's Budget proposals, there was little anticipatory activity in the mining sections. This was understandable enough in a section of the market where interests are centred overseas. Even so, the Budget did contain some good news for mining shareholders.

The most important proposal for these shareholders was, of course, the reduction of 9d. to 7s. 9d. in the standard rate of income tax. This will be reflected in larger net dividends received in future. As far as the companies themselves are concerned, many of them are domiciled overseas and their profits are outside the scope of U.K. tax rates—they have their own problems. Others which are registered here often already benefit from O.T.C. concessions and are unlikely to be further affected to any great extent. But there are still quite a few mining companies which lie outside the scope of O.T.C. arrangements and they will share the same new tax benefits as industrial companies in this country. Several of the mining finance houses come into this category, among them are Anglo-French, Central Mining, Gold Fields, C.M.S., Johnnies, Union Corporation and Selection Trust. Consolidated Zinc should be helped to some extent and among tin companies the Cornish mines, South Crofty and Geevor, will be better off from the tax point of view. In addition, the base metal mines may get some indirect benefit from an increased U.K. metal consumption resulting from the prospective expansion in industrial activity which the Budget has clearly been designed to accelerate.

A concession of less widespread application is the alteration in the basis of initial allowances for new mining works. In future such works will qualify for a 20 per cent investment allowance and a

20 per cent initial allowance compared with the present 40 per cent initial allowance. As in the case with the reduction in standard rate, companies qualified as O.T.C. will not, of course, benefit but the concession should be of advantage to such companies as South Crofty and Geevor.

One of the few talking points in an otherwise subdued gold share section was the suspected U.S. buying of Welkom. This raised the shares to 21s. at one time before a subsequent reaction to 19s. 10½d. Free State Geduld, which in the previous week had touched a new peak of 185s., steadily fell back to 170s. before rallying to 173s. 9d.; profit-taking was linked with a feeling that the coming March quarterly report may not hold further exciting news from the rich strike area in the vicinity of No. 1 shaft. Stilfontein (43s. 6d.) were also subject to some apprehension in front of their quarterly.

Diamonds brightened on the announcement of record March quarter sales and De Beers reached 132s. 6d. at one time with "Casts" forging ahead to 18s. 9d.

Tin shares responded to the encouraging fact that, at the start of a new sales quota period, the metal price had moved confidently above the buffer stock manager's permitted selling level of £780 a ton. The market was also pleased with the latest batch of interim dividends and accordingly bid for Tanjong (18s.), Southern Malayan (13s. 1½d.) and Malayan (15s. 6d.) among several others.

Narrow price fluctuations in quiet trading characterized the Copper share market. Occasional bouts of Continental selling took place and matters were not helped by a setback in the metal price. Chartered reacted from the 87s. 9d. reached in the previous week's advance, but after falling to 85s. 9d. the shares rallied to 86s. 3d. following the resumption of investment support.

In the case of industrial stones, a spokesman of the Diamond Corporation in London went to some pains to explain that last quarter's high figure was in part due to purchases for the United States Government stockpile. These were made under a barter deal whereby the stones were acquired in exchange for American surplus farm products. The diamond producers as such would, of course, get cash for their sales. Although further deals of this kind may be negotiated, therefore, they are unlikely to be on the same scale as during the past three months. There is thus a fair degree of certainty that the June quarter trading in industrial material will be less than in the March period. It has also to be borne in mind that there may be stiffer competition in the United States from General Electric's manufacture of synthetic board.

The following table shows the prices and yields of Anglo American Investment Trust, the diamond shareholding company, Consolidated African Selection Trust, which produces diamonds in Sierra Leone and Ghana, and De Beers itself.

	Price s. d.	Div. s. d.	Yield %
Anglo Amer. Inv.	240 0	20 0	8.3*
Cons. African Sel.	17 6	3 6†	20.0
De Beers Defd.	130 6	10 0	7.7*

\* Excluding any double taxation relief.  
† Including special interim of 1s.

It seems fair to include Cast's special interim on account of the year to June 30 next in the 1957-58 total as it was declared in lieu of a higher final in order to keep profits tax to a minimum. It has been officially stated that the normal interim for 1958-59 will be declared next month.

## GOOD DIVIDENDS FROM MALAYA

There has been some further evidence this week of the way in which the leading Malayan tin concerns are weathering the storm caused by restriction of output under the international agreement. The evidence has been provided in the tangible form of better dividends. The payments are naturally below those of the previous year, but they are none the less satisfactory for that. The accompanying table summarizes the position.

	To date s. d.	Last year s. d.	Total last year s. d.	Price s. d.
Malayan	6 8	1 10	15 6	
S. Malayan	6 8	2 0	13 0	
S. Tronoh	9 1 0	2 6	11 9	
Tronoh	1 4 2 0	3 0	13 0	

For Malayan and Southern Malayan, the payments to date are the sum of the first two interims for the financial year to June 30 next. For 1957-58, there were four interims followed by a final in November. These two companies are now paying out on account of a year that in its last quarter at least has seen some loosening of the output restriction screw.

Tronoh and Southern Tronoh, on the other hand, are declaring dividends for the calendar year 1958 which covered what should have been the worst of the tin crisis. For Tronoh, the present 4d. is a fourth interim. For 1957, it was followed by a final declared last August. This was of 6d. together with a bonus of a similar amount. Nothing like this can obviously be expected on this occasion,



particularly as there is an additional factor, namely: that 1957 saw the initial and consequently maximum impact on Tronoh of the Overseas Trade Corporation tax benefits. If the final were only 4d., however, making 1s. 8d. for the year, the yield would be 12.8 per cent, which is an excellent return for a tin producer in a bad year, especially for one that has little in the way of life worries. Tronoh is incidentally producing Southern Tronoh's output quota "upon mutually satisfactory terms".

For Southern Malayan, it is reasonable to look for total dividends on account of 1958-59 of something in the neighbourhood of 1s. 6d., which would put these 5s. shares on a potential 11.5 per cent yield basis. For Malayan, 1s. 6d. may also be in view. Why, then, should these shares stand higher than those of Southern Malayan? The answer presumably lies mainly in Malayan's new dredge, which is due to come into operation early in the company's next financial year. It is understood that this dredge will receive an output quota when operations are ready to begin. It should be able to operate at a profit even if output restriction remains at its present level.

#### TANJONG AND KINTA PAY WELL

On Wednesday evening, two further encouraging tin dividends were announced. Both were first interims for 1959 by Tanjong and Kinta. Tanjong's payment of 9d. compares with 6d. at this time last year, which was followed by three further interims, making a total of 1s. 9d. to date for 1958. For the previous year, this was capped by a final in June. The 5s. shares at 18s. 3d. would yield 9.6 per cent, even if the distribution for the bad tin year of 1958 were not augmented by a final. With the good start to the payments for the current period, it is reasonable to expect that Tanjong in due course should regain the price range of up to 25s. that they used to command.

Kinta's first interim of 6d. for 1959 had no counterpart last year, when the first payment of 3d. was declared in October, followed by a second interim of 6d. in January. There could still be a balance payment on account of 1958. The 2s. shares are 18s. 9d. and are difficult to value on a dividend basis, but it is notable that they are a Singapore favourite.

#### RHODESIAN CORPORATION PROFITS LOWER

Rhodesian Corporation's profits underwent a sharp contraction in the year to September 30 last from a gross figure of £212,244 to £120,965. This was largely due to a drop from £72,347 to only £3,655 in the surplus on the sales of properties. In the previous year this surplus was swollen by the sale of the Ventersburg estate. There was a decline of close on £6,000 to £61,993 in dividends and interest which the chairman, Mr. F. R. Peters, attributes to the realization of certain of the company's investments. He says that advantage has been taken of opportunities for the reinvestment of the available funds and he is able to point out that the market value of quoted investments is now £609,303 compared with £589,452 on September 30 last.

After depreciation, and a small amount of taxation and other charges, the corporation's net profit comes out at £68,073 against £132,252 in 1956-57 and the divi-

## Coming Events

The forthcoming exhibition at Olympia in July, sponsored by the Council of Underground Machinery Manufacturers has now attracted twenty-six member firms of the C.U.M.M. and nearly eighty other manufacturers of underground machinery or ancillary equipment. This is remarkable when it is remembered that at the C.U.M.M. Exhibition in 1949 there were only a few dozen exhibitors. The export drive by manufacturers of British mining machinery will reach its peak during the exhibition, and to encourage still greater overseas interest the C.U.M.M. has just sent off more than 35,000 copies of a brochure containing the names of exhibitors, details of the exhibits, and other information, to associations, institutions, and individuals connected with the mining industry all over the world.

A paper on "The Uranium and Thorium Resources of the Commonwealth" will be delivered by S. H. U. Bowie, B.Sc., M.I.M.M., at the Royal Society of Arts, John Adam Street, London, at 5.15 p.m., on April 23, 1959.

The Pneumatics and Hydraulics for Industry exhibition and convention is to be held at Alexandra Palace from October 12 to 16, 1959.

The eleventh annual general meeting of the Cornish Mining Development Association will be held at 7.30 p.m. on April 30, 1959, in the Lecture Theatre of the School of Mines, Camborne.

#### MINING FINANCE—Continued

dend, maintained at 10 per cent on the 3s. 4d. stock units for the fifth successive year, takes £62,150 net. The carry-forward is little changed at £70,120 owing to the amount written off unquoted investments having been lowered from £34,025 to £2,499.

One of the corporation's major projects at the moment is the erection of York House at Bulawayo, in Southern Rhodesia. At the end of last September £159,854 had been spent on this and it is estimated that a further £193,000 will see it to completion. Mr. Peters adds the warning that the building may not be fully let for a time owing to the decline in "recent boom conditions". Mr. Peters, in fact, is disturbed about the possible consequences to Southern Rhodesia's economy of "over-optimism in a still expanding country".

Rhodesian Corporation units stand at 3s. 4d. to yield almost exactly 10 per cent. On this basis they are a reasonable enough investment of their kind. It is likely that their true asset value is considerably higher than that represented by either the market price or the balance sheet.

#### ANGLO-FRENCH MAY PAY MORE

The most important part for stockholders of Mr. F. R. Cottell's speech at the annual meeting of the Anglo-French Exploration Co. was that which dealt with the directors' decision to start the payment of interim dividends next September on account of the year that ends on December 31. Mr. Cottell said that this decision stemmed from the steady

## Obituary

#### JOSEPH ROUSSEAU

We regret to report the death, on March 30, of Joseph Rousseau. He was 77. Highly regarded throughout the Belgian mining industry, Mr. Rousseau was for many years Brussels correspondent to *The Mining Journal* and *The American Metal Market*.

Mr. Rousseau was born at Jambes, a grandson of the founder of the first Belgian newspaper. In 1904, he entered journalism, becoming correspondent to French marine journals. Later appointed to *Le Matin* (Paris) and *Le Matin* (Brussels), he became correspondent to *African World* in 1906, and held this position until his death. From 1907 until 1922, Mr. Rousseau was Brussels correspondent of the *Daily Mail*. In later years, he became colonial correspondent of *Echo de la Bourse* and later of *Agence Economique et Financière*.

A vigorous campaigner for closer ties between Belgium and the Congo, he served his country with distinction during the First World War, being decorated by King Albert I. At the end of his life, the principal decorations held by Mr. Rousseau included Officier de Ordre de Leopold II, Chevalier de l'Ordre de Leopold, Officier d'Academie, as well as many other honours, both Belgian and foreign.

Honorary vice-president of the Belgo-Congolaise Press, Mr. Rousseau will be mourned in journalistic and mining circles throughout the world.

rise which had taken place in income from dividends on investments and the prospect "for several years ahead of further increases in the rates of dividend declarations by the new mines in the Far West Rand and the Orange Free State". He went on to say that the operation of double-tax relief should also have a beneficial effect on Anglo-French's income.

It thus looks as though the gradual advance in the company's own dividends that has taken place in recent years should be resumed in 1959. For each of the last three years 1s. 10½d. per £1 stock unit has been paid. The yield at 27s. 6d. is 6.8 per cent.

#### THE WORLD'S GREATEST BOOKSHOP

**FOYLES**  
FOR BOOKS

Your customers are as fascinating as your books! In half-an-hour at Foyles you can see people from almost every country in the world—people of every colour, every race, every nationality. It is a wonderful bookshop.

—A Member of Parliament

TRAVEL BUREAU NOW OPEN  
Road, Rail, Sea, Air tickets

119-125 CHARING CROSS ROAD  
LONDON, WC2

Gerrard 5660 (20 lines) ★ Open 9-6 (incl. Sats.)  
Two mins. from Tottenham Court Rd. Sta.



## ANGLO-FRENCH EXPLORATION

### DIVIDEND MAINTAINED ON INCREASED CAPITAL

The Sixty-ninth Annual General Meeting of the Anglo-French Exploration Company, Limited, was held on April 1 in London.

The Chairman, Mr. F. R. Cottell, A.C.A., in the course of his speech, said:

Our investments stand in the books at £1,191,186 and are valued at £1,860,971, a surplus of £669,785. The increase in this surplus compared with the figure at the end of 1957 is mainly accounted for by the rises which have taken place in the stock exchange values of our shareholdings in gold mining companies.

The classification of our investments, based on the valuation at December 31, 1958, is:

	%
Gold mining (including holding companies which have substantial interests in gold mining companies) .....	55.6
Oil .....	19.5
Copper, lead, zinc .....	8.7
Coal .....	8.2
Tin .....	3.4
Diamonds .....	2.6
Platinum .....	1.3
Miscellaneous .....	0.7

The profit and loss account continues to reflect a rising trend in our receipts from dividends and interest on investments which at £134,696 compares with £128,017 last year, although a part of this higher figure is due to the increase in capital in April last. The profit of £36,454 realized by sales of shares and sundry credits, against £32,715 in 1957, brings our total revenue to £171,150, an increase of over £10,000. Office and general expenses have been held at approximately last year's figure and taxation on the larger profit is about the same as the charge for last year. We have applied £13,567 in reduction of book value of investments which leaves a profit for the year, after taxation, of £56,164 against £50,014 in 1957.

As indicated at the annual meeting in 1958 the dividend which we recommend on the larger capital is 1/10d per £1 unit of stock which, after deducting income tax at 8/6d in the £, will require £53,906 leaving £9,269 unappropriated profit to be carried forward.

### Interim Dividends

I now refer to the statement in the directors' report that it is the intention to commence the payment of interim dividends in September next. This stems from the steady rise which has taken place in our income from dividends on investments and the prospect, for several years ahead, of further increases in the rates of dividend declarations by the new mines in the Far West Rand and the Orange Free State in which we are interested. There is another factor concerning these dividends which should have a beneficial effect on our income, namely, the operation of double taxation relief and provided only that the rates of dividend declarations are at least maintained our net cash receipts from these sources will be correspondingly greater. Your directors consider that this improved outlook for the dividend income of your company justifies the commencement of interim dividend payments.

## Rand and Orange Free State Returns for March

### GOLD OUTPUT AND PROFIT

Company	March 1959				Current Financial Year				Last Financial Year			
	Tons (000)	Yield (oz.)	Profit† (£000)	Year ends	Tons (000)	Yield (oz.)	Profit† (£000)	Total to date	Tons (000)	Yield (oz.)	Profit† (£000)	Total to date
<b>Gold Fields</b>												
Doornfontein .....	90	37,125	180-0	J	790	328,473	1685-4	769	317,725	1760-5		
Libanon .....	100	23,967	53-0	J	882	208,717	482-8	1,008	206,528	480-0		
Luipaards Vlei .....	72	12,509	4-6	J	629	109,323	47-6	643	115,121	64-7		
Rietfontein .....	16	4,132	6-0	D	48	12,732	22-7	67	15,379	42-5		
Robinson .....	66	13,700	121-3	D	196	40,672	163-5	214	45,534	17-7		
Simmer & Jack .....	84	15,316	123-5	D	258	49,307	15-3	249	49,273	42-3		
Sub Nigel .....	66	15,874	23-8	J	593	142,830	219-2	592	149,567	247-7		
Venterspost .....	130	32,253	57-2	J	1,147	286,179	521-7	1,085	262,241	495-9		
Vlakfontein .....	50	17,939	85-1	D	148	53,254	251-3	146	51,479	247-9		
Vogels .....	96	21,534	41-6	D	276	62,714	125-4	288	65,314	137-7		
West Drie .....	90	82,806	676-8	J	738	700,165	5721-6	677	649,744	5403-7		
<b>Anglo American</b>												
Brakpan .....	141	17,000	11-9	D	407	48,694	28-1	359	49,898	31-8		
Daggas .....	242	49,352	244-0	D	699	142,813	728-2	652	137,667	708-0		
East Daggas .....	100	16,694	31-3	D	283	47,159	84-5	265	44,129	78-3		
F. S. Geduld .....	79	61,764	450-6	S	448	339,096	2474-4	382	273,267	1885-6		
President Brand .....	100	77,504	654-7	S	580	439,800	3759-4	434	324,763	2611-6		
President Steyn .....	99	38,330	194-0	S	557	217,349	1107-4	554	246,119	1236-1		
S. A. Lands .....	93	19,577	56-5	D	273	57,412	164-2	256	52,725	147-3		
Springbok .....	104	14,286	11-1	D	307	42,246	29-3	372	41,469	23-2		
Vaal Reefs .....	83	37,682	202-5	D	239	108,668	597-6	200	89,767	512-0		
Welkom .....	95	29,230	79-2	S	545	165,861	461-7	488	144,355	391-1		
Western Holdings .....	107	64,200	487-6	S	603	357,617	2713-3	574	301,131	2918-2		
West. Reefs. Ex. .....	121	31,460	90-2	D	341	88,241	242-4	327	76,206	168-0		
<b>Central Mining</b>												
Blyvoor .....	120	77,520	553-0	J	959	628,675	4550-6	926	545,961	3863-6		
City Deep .....	114	23,950	10-4	D	338	70,762	31-6	431	82,117	27-7		
Cons. M.R. .....	125	20,419	14-2	J	1,232	181,563	129-3	1,436	201,462	91-1		
Crown .....	220	34,149	8-5	D	655	102,261	24-6	676	103,800	48-0		
D. Roodepoort .....	184	34,136	50-9	D	549	101,062	154-3	531	95,729	149-2		
East Rand Prop. .....	221	56,906	124-5	D	645	166,075	353-2	650	167,119	439-5		
Harmony .....	115	45,732	180-7	J	913	366,042	1434-6	722	290,735	1420-3		
Modder Deep .....	128	13,210	2-4	J	1,196	118,441	19-3	1,224	122,965	23-0		
Rose Deep .....	43	5,377	0-3	D	117	16,206	10-1	169	23,438	13-7		
<b>J.C.I.*</b>												
Freddies Cons. ....	56	14,173	138-3	D	166	41,521	1108-6	139	46,999	158-4		
Govt. G.M.A. ....	50	10,592	12-7	D	165	31,852	116-7	187	32,668	3-9		
Randfontein .....	32	6,070	9-1	D	89	15,551	23-3	80	13,803	15-2		
<b>Union Corporation</b>												
East Geduld .....	130	39,652	261-2	D	390	119,616	805-3	368	113,162	763-2		
Geduld Prop. ....	68	13,029	15-4	D	206	38,154	41-7	243	38,360	30-3		
Grootvlei .....	200	42,394	203-4	D	595	126,230	618-8	570	121,514	617-8		
Marievale .....	92	22,978	109-5	D	265	67,014	317-5	211	55,458	244-1		
St. Helena .....	140	42,002	220-3	D	415	123,250	647-2	339	100,339	438-9		
Van Dyk .....	76	14,361	25-0	D	225	42,450	75-1	224	39,872	64-0		
Winkelhaak .....	69	16,794	27-5	D	206	48,285	63-8	—	—	—		
<b>General Mining</b>												
Buffelsfontein .....	134	47,069	225-1	J	1,103	375,294	1728-1	985	322,679	1694-3		
Ellaton .....	31	7,318	30-0	D	91	21,488	90-2	94	21,645	98-8		
S. Roodepoort .....	29	6,979	22-4	J	267	63,451	211-9	264	62,208	225-8		
Stilfontein .....	135	67,357	419-5	D	387	196,002	1255-2	325	161,330	925-9		
W. Rand Cons. ....	138	19,685	17-8	D	387	55,865	46-4	461	51,096	29-6		
<b>Anglo Transvaal</b>												
Hartebeestfontein ..	87	46,980	317-2	J	779	84,847	2867-4	762	417,850	2811-1		
Lorraine .....	75	14,625	120-4	S	446	87,056	1113-2	376	71,608	1103-1		
N. Klerksdorp .....	11	1,143	18-3	D	30	3,191	124-8	31	3,171	122-5		
Rand Leases .....	188	28,294	21-0	J	1,632	239,003	122-6	1,518	230,364	66-8		
Village M.R. ....	26	4,780	1-0	J	242	42,865	7-8	285	46,777	42-4		
Virginia O.F.S. ....	122	30,701	7-4	J	1,016	262,684	311-5	900	222,074	509-1		
<b>Others</b>												
N. Kleinfontein ....	83	10,898	3-1	D	245	32,069	9-1	276	33,611	1-5		
Wit. Nigel .....	18	4,366	5-4	J	160	38,806	53-6	160	38,447	45-3		

Gold has been valued at 248s. 9d. (February 248s. 11d.) per oz. fine. L indicates loss. † Working Profit. \* Working Profit includes sundry revenue. Table excludes profits from Uranium, Pyrite and Acid, and also production from Uranium divisions at Luipaards Vlei, Randfontein and W. Rand Consolidated.

### ESTIMATED URANIUM REVENUE

Company	Year ends	March Profit (£000)	This year (cum.) (£000)	Last year (cum.) (£000)	Company	Year ends	March Profit (£000)	This year (cum.) (£000)	Last year (cum.) (£000)
<b>Gold Fields</b>					<b>J.C.I.</b>				
Doornfontein ....	J	14-0	133-0	188-0	E. Champ d'Or (b)	D	6-6*	19-4*	18-2*
Luipaards Vlei (a)	J	92-0	810-0	800-0	Freddies Cons. ....	D	34-0*	98-0*	77-0*
Vogels .....	D	52-0	152-0	156-0	Govt. G.M.A. ....	D	22-0*	66-1*	69-0*
West Drie .....	J	48-0	416-0	391-0	Randfontein (a) ..	D	106-1*	322-5*	330-3*
<b>Anglo American</b>					<b>General Mining</b>				
Daggas .....	D	138-0	423-2	404-0	Buffelsfontein ....	J	205-0	1787-0	1195-0
President Brand ..	S	43-0	278-0	267-0	Ellaton .....	D	19-0	59-0	50-0
President Steyn ..	S	58-0	363-0	347-0	Stilfontein .....	D	87-0	267-0	265-0
Vaal Reefs .....	D	136-5	416-4	359-0	W. Rand Cons. (a)	D	200-9	598-0	629-9
Welkom .....	S	54-0	342-0	317-0	<b>Anglo Transvaal</b>				
West. Reefs Ex. ..	D	156-3	472-8	457-0	Hartebeestfontein ..	J	258-0	2316-6	2129-3
<b>Central Mining</b>					Lorraine .....	S	35-0	206-0	181-0
Blyvoor .....	J	159-5	1383-9	(c)	N. Klerksdorp .....	D	11-5	32-0	39-0
Harmony .....	J	172-0	1339-5	(c)	Virginia O.F.S. ....	J	183-6	1660-5	1639-6

Table includes profit from uranium, acid and pyrite before loan redemption. (a) Total profit from uranium section. (b) Overall profit. (c) Figures not available. \* Net revenue after provision for loan redemption.

## The Engineering, Marine, Welding and Nuclear Energy Exhibition, 1959

The Engineering, Marine, Welding, and Nuclear Energy Exhibition is being held at Olympia from April 16 to April 30. Many of the exhibits are of interest to the mining industry.

*Goodyear Pumps Ltd.* will be exhibiting for the first time a complete range of products which feature the revolutionary positive displacement rubber-to-metal Goodyear self-priming pump. The range of exhibits includes pressure systems and marine pumps. An important introduction, and shown for the first time, is the new face-drainage mining pump. Comprising a Goodyear A12 pump and English Electric flameproof  $7\frac{1}{2}$  h.p. motor mounted to a skid base, this pumping unit has an output of 75 gal. per min. with a 200 ft. head of water and a 28 ft. suction lift. A further new product on the Goodyear stand will be a working exhibit of the new process pumping set and fire pumps.

One of the main features on the stand of *G. A. Harvey and Co. (London) Ltd.* will be an 11-ton wire-weaving loom in operation. This loom is capable of weaving wire from 0.020 in. up to 0.220 in., either plain or twill weave, and is one of the many looms installed at the Harvey works.

*Nuclear Engineering Ltd.*, an associate company of *G. A. Harvey and Co. (London) Ltd.*, will be exhibiting on the Harvey stand gamma radiographic equipment for the non-destructive testing of metals, alloys, plastics, and assemblies.

*Maxam Power Ltd.* will show a wide range of fluid power equipment. On the stand will be shown a range of Maxam air cylinders and control valves. A recently introduced Mark II range of air cylinders, suitable equally for air and low-pressure hydraulic use, deserves special mention. A working exhibit certain to attract attention is a fully automatic jaw-type extractor.

*Atlas Copco (Great Britain) Ltd.* will show a new quiet pneumatic screwdriver, the LBU 12, now being introduced to the British market. The Atlas Copco LSF 12 small grinder represents the latest development in small high-speed air-driven tools for rotary cutting and grinding, while the LSS 82 surface grinder is designed to take full advantage of the latest developments in high-speed abrasive and cutting wheels.

*The Mond Nickel Co.* will feature the properties of nickel, nickel-containing materials, the platinum metals, and S.G. iron. The stand will illustrate, largely through animations and demonstrations, the properties of materials containing some of the company's products, and will cover corrosion resistance, plating, welding, physical properties, strength at high temperatures, and toughness at sub-zero temperatures. Several of the demonstrations will be on view at the exhibition for the first time.

A number of entirely new exhibits are being revealed for the first time to the public in a joint display by *Ruston and Hornsby Ltd.* and their associates *Davey, Paxman and Co. Ltd.* The group's stand has been divided into two main sections

in which water-cooled and air-cooled diesel engines are displayed separately. In the water-cooled engine section, two completely new power units may be seen. These engines are the Ruston 6ATC and the Paxman Ventura, both units being of revolutionary design. In the section devoted to a representative selection of the latest air-cooled engines produced by the Ruston group, the largest air-cooled power unit in commercial production in the world may be seen. This engine is from Paxman's new Vega range of vee-form air-cooled diesels which cover 200 to 466 b.h.p., and now enables the group to offer air-cooled power units ranging from 4 to 466 b.h.p. The first product from the group's nuclear engineering department also is being shown in public for the first time.

The largest item which the *Consolidated Pneumatic Tool Co. Ltd.* will be exhibiting will be one of their class FE range of compressors, shown for the first time at this exhibition. Some new additions to the lightweight range of pneumatic tools will also be shown. These include small  $\frac{3}{8}$  in. and  $\frac{1}{2}$  in. drills with 45 deg. and 90 deg. angle heads and a new lightweight angle sander on which flexback pads can be fitted for sanding curved surfaces. A special model is being exhibited fitted with a water feed for dust suppression. A new fast, medium-weight rock drill for tunnelling, introduced last year under the name Tornado, will also be on show.

Among the exhibits of the *Hawker Siddeley Group* will be an interesting and comparatively new form of power generator, a free piston gasifier turbine installation, shown by National Free Piston Power Ltd. and manufactured by the National Gas and Oil Engine Co. Ltd. and Brush Electrical Engineering Co. Ltd. Other Hawker Siddeley Group exhibits range from high-speed lightweight air-cooled diesel engines to a Handraulic starter, fuel cans manufactured for the United Kingdom Atomic Energy Authority, and various items of precision electronic equipment.

On the *Westinghouse Brake and Signal Co. Ltd.* stand, a working exhibit representing an excavator control cabin will demonstrate the ability of pneumatic apparatus to cater for a wide variety of controlled movements, and will show how Westinghouse controls give the driver "fingertip" operation of the main earth-moving functions. Backing up these exhibits will be a static display of typical pneumatic valves and cylinders, together with a closed circuit film showing various applications of this apparatus.

*Worthington-Simpson Ltd.* will be showing a representative selection of centrifugal, steam, and marine pumps, from their wide range of products, together with rotary and Monobloc air compressors and a marine condensing plant complete with inter- and after-cooler, ejector, and extraction pump. One of the Monobloc pumps will feature the new Worthington-Simpson flameproof motor enclosure. A central priming unit will be displayed as a working model. Maximum capacities of the pumps exhibited will be 3,900 g.p.m. with heads up to 600 ft.

## Book Reviews

**Kempe's Engineers Year-Book for 1959.** 64th Edition. Published by Morgan Brothers (Publishers) Ltd. Price (two volumes in case) 82s. 6d. plus postage.

Three sections of the 1959 Kempe's Engineers Year-Book have been revised and re-written, namely: those entitled "Flow Metering and Mechanical Testing", "Refrigeration", and "Paints and Varnishes". As usual, a great many alterations and additions have also been made to bring the information up to date. There are a number of new illustrations, and necessary alterations and additions to the index provide easy access to the contents of the Year-Book. Containing respectively 1,416 and 1,324 pages, the two handsomely bound volumes contain a wealth of engineering data in readily accessible form.

**The Engineers Buyers Guide, 1959 Edition.** Published by Morgan Bros. (Publishers) Ltd., 28 Essex Street, Strand, London, W.C.2. 960 pp. 7s. 6d.

The Buyers Guide section of the volume consists of 744 pages and contains over 33,500 entries arranged under approximately 2,500 classified headings, with 1,500 cross-references to help the user find what he wants. A new feature included for the first time is a list of forthcoming engineering and industrial exhibitions, in addition to a list of addresses of national undertakings. Firms representing every branch of industry appear in this valuable and up-to-date list of suppliers of a wide variety of engineering products and services.

★

*The Statistical Summary of the Mineral Industry* is an annual publication of statistical tables, published by H.M. Stationery Office, covering a period of six years, showing world production, exports and imports of all the important economic minerals and metals. This edition covers the period 1952 to 1957, and is prepared by the Mineral Resources Division, Overseas Geological Surveys. Production tables for cobalt, copper, lead, tin, and zinc show not only the output of relevant ores in terms of metal, but also give figures of metal production. So far as possible, the latter tables give the amount of primary metal obtained, showing separately, wherever important, production of secondary metal. Thus it is possible to see at a glance the amount of new metal available in any year. The cost of the book is £1 7s. 6d. net.

★

The quarterly bulletin of the Overseas Geological Surveys, *Overseas Geology and Mineral Resources*, Vol. 7, No. 3, has several interesting articles. Included are "Outline of the Geology of Ruwenzori Mountains—a preliminary account of the British Ruwenzori Expedition, 1951-52", "Rapid determination of Titania in Ilmenite-Cassiterite Ores", and "Progress Report of the Overseas Geological Surveys, 1956-57". The volume is edited by Mr. E. H. Beard, B.Sc. (Lond.), Deputy Principal, Mineral Resources Division, and published by H.M.S.O. for 10s.

1959

1959.  
organ  
(two  
stage.

mpe's  
evised  
ntitled  
Test-  
s and  
many  
been  
up to  
illus-  
s and  
easy  
Book.  
1,324  
ound  
eering

1959  
Bros.  
Street,  
pp.

olome  
s over  
proxi-  
with  
e user  
are in-  
forth-  
exhibi-  
dresses  
repre-  
appear  
list of  
eering

Min-  
ion of  
H.M.  
iod of  
on, ex-  
oportant  
This  
1957,  
l Re-  
logical  
cobalt,  
ot only  
rms of  
al pro-  
latter  
metal  
erever  
ondary  
e at a  
avail-  
e book

verseas  
eology  
No. 3,  
cluded  
Ruwen-  
account  
edition,  
on of  
Ores",  
verseas  
The  
Beard,  
Mineral  
ned by